Vol. 27 SEPTEMBER, 1905 No. 157

THE FOUNDRY

PUBLISHED MONTHLY BY
THE PENTON PUBLISHING CO.
CLEVELAND, OHIO.

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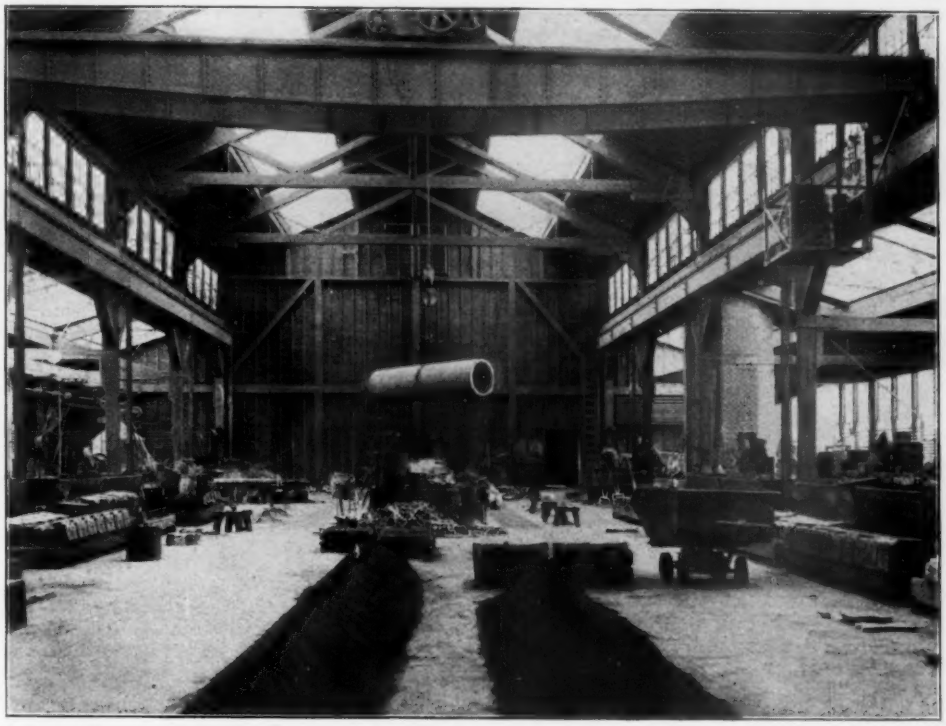
THE FOUNDRY

Vol. 27, No. 1. *CLEVELAND, OHIO, SEPTEMBER 1905.* *Whole No. 157*

A Modern Jobbing Brass Foundry.

The majority of manufacturers would not think of making their own tool steel or even their own nuts, caps, screws, etc. This is the result of specialization which is being carried further every day in the lines of manufacture. This specialization has been carried into many new fields in late years and today we have specialties of all classes. In the gray iron field we have foundries which make nothing but pulleys or power transmission machinery, and so on through a long list of specialties. The mixing of alloys and similar metals and the casting of the special metals now so extensively used have led to the establishment of a number of important works specialized along these lines. One of the largest and best equipped plants of this kind in the country is that of Clum & Atkinson, of Rochester, N. Y. This company commenced business 23 years ago, and during that time has experienced a steady growth. At present it occupies a factory covering an area of 100 x 326 ft. and has found it necessary to incorporate with its plant much equipment not ordinarily found in a brass foundry. The foundry proper is 100 x 150 ft. The central bay, which contains the heavy work floor and melting pots, is spanned by a five-ton electric traveling crane. Other hoists are installed where necessary for handling material for dif-



CENTRAL BAY OF FOUNDRY.

SIDE BAY OF FOUNDRY.

MELTING FURNACES.

ferent departments. Trucks or special cars are also used for transporting material about the works. The sand storage and metal storage are arranged at one end of the foundry, and the core department is situated on one side of the main bay. For drying the larger cores there is an oven 12 x 18 by 8 ft. in height.

A very large accumulation of patterns has to be kept on hand at all times and, hence, a fireproof pattern storage vault, 20 x 65 ft. has been provided and equipped with suitable shelving upon which the patterns are stored in such a manner that any of them can be found by reference to the pattern storage records.

FIREPROOF PATTERN VAULT.

As a large number of metal patterns are used, it has been found necessary to equip a metal pattern shop with a milling machine, the necessary equipment of lathes, benches, vises, etc. This department gives regular employment to several men. One very interesting feature in connection with the plant is the machine shop, in which many of the brass castings are partially or wholly finished. There are two great advantages in following this course. In the first place the purchaser of the castings does not have to pay freight or express on the material turned off during the finishing; in the second place the metal removed in this manner is retained at the brass foundry and can be immediately returned to the furnaces for use in new mixtures. This results in a double saving which, when considered together with the fact that the machine work can usually be done in Rochester as cheap as anywhere else, explains why with a given grade of material this company can frequently quote lower prices than others. As is usually the case, the company has certain specialties. One of its specialties is aluminum and aluminum alloy castings for automobile parts and similar work. The company has done a great deal of experimenting along this line and is equipped to furnish anything of this nature which may be required. It has also made a specialty of railroad work, including all classes of bearings and keeps a full set of master car builders' patterns on hand at all times, so that it is prepared to furnish any standard size of bearing promptly. In connection with the automobile work, gas engine work, etc., the company has made a specialty of manganese bronze castings intended for connecting rods, propeller blades, etc.

In addition to the production of castings this company has long been noted for the babbitt turned out by it. It sells a number of different grades of babbitt suited for different classes of work.

One of the most interesting features about the plant is the provision for the comfort of the workmen. In the basement, under the machine shop and metal pattern department, are located the shower bath and locker rooms for the use of the men, each employe being allowed the use of a locker. There is also a room provided with tables

where the men may rest and eat their lunch during the noon hour.

The plant is equipped with its own power plant, which furnishes electricity for the cranes, lights, etc., and power for the various shops; also compressed air for use in connection with various pneumatic appliances. The buildings are so constructed as to insure a maximum amount of daylight whenever it is available, and artificial lights are so located as to facilitate the work to the greatest possible degree when night work is necessary or when dark days render some portions of the day too dark for efficient work.

The arrangement of the different units of the plant is such that the material goes in at one end, passes through step by step and out at the other end as the finished product. There is a siding from the New York Central which connects with the works, so as to permit the bringing in of carloads of supplies or the shipment of carload lots of work.

TEST BARS.

BY W. H. FONDA.

I have read the article on "Test Bars" in the May *Foundry* by B. J. Dunning, with a great deal of interest, as I have felt many times the same discouraged feeling that he mentions. At times I have felt that a test bar was a guide which could be relied on, but until we employed a chemist about two years ago we were generally at sea regarding the qualities of the iron used in our mixtures.

We have had it demonstrated to our entire satisfaction that the furnace analysis is not correct enough to use as a basis for making mixtures, except in cases where they know that you intend to check against them. If the furnace man knows that his analysis will be checked he will try to fill your specifications within a few points. This point is well illustrated by an experience of ours in 1903 when every one was wanting pig iron. We had a good many carloads delivered that were supposed to contain 2.50 percent silicon, 0.50 percent phosphorus, 0.005 percent sulphur. A mixture was made from this iron and the castings gave a great deal of trouble by breaking and there was also a very low strength shown in the test bars. We then had an analysis made and found that the silicon was over 4 percent, phosphorus 1.48 percent and sulphur .130 percent. During the time that we were having so much trouble with job lots of iron, we were relying upon test bars rather than upon analysis. Several test bars were made from every heat, and even when the mixture was supposed to be the same there would frequently be a difference of from 300 to 400 pounds in the breaking strength of the test bars. Since we have been having a chemist make the analysis of the pig iron and also drilling and analyzing the test bars each day, we have been able to produce a uniform grade of castings. In fact, we are making the best castings that we have ever made, in over thirty years' experience in foundry work.

The first part of the heat is a 25 percent semi-steel mixture. This metal is used in our gearing and castings requiring the greatest amount of strength. During the time we are pouring from the semi-steel mixture we make test bars Nos. 1 and 2. Six other bars are made throughout the rest of the heat, being so located as to represent average conditions as closely as possible. For the semi-steel we mix No. 2 malleable Bessemer 25 percent, No. 1 Ohio 35 percent, No. 1 Virginia 15 percent, and scrap steel 25 percent. Our test bars are carefully made by the same man each day and measured, weighed and tested by the inspector. The bars are broken on a Reihle testing machine and a record kept of each bar. All gears cast from semi-steel are dated with the day of the month, the month and year. In case of any break we can refer to the mixture that was used on that date. I am glad to state that during the last two years while we have been following the present methods we have not had a single complaint, or a defective casting returned from customers.

I agree with Mr. Dunning that test bars are not in themselves a satisfactory pilot to guide us in making a uniform mixture that will give us the same results each day. The test bars, however, do give us the comparative strength of our iron and we can get these results early in the morning, before we get the report from the chemist. Our analyses are made by the Detroit Testing Laboratory, of Detroit, Mich., and as this is located 60 miles away from the shops, the determination cards

are not ready until noon of the next day.

If the chemist finds anything wrong with the analysis, however, he 'phones us before the blast goes on and tells us what changes to make in the mixture.

I know that there are a great many foundries that still make their mixtures mostly by guess or by fracture, which is certainly guessing, and then they wonder why some days iron is too hard and other days too rotten to use. In my experience in cupola work I have learned that no matter how careful one is it is impossible to get the same results every day when melting from 40 to 50 percent of miscellaneous scrap in the mixture. Sometimes the scrap is light and will melt before the pig iron does and in that case we can only get the iron uniform in the mixture by holding it in the cupola until we have from 3,500 to 4,000 pounds melted and then tapping it into a large ladle where it will be mixed uniformly. In conclusion I would say that I believe test bars are valuable but we can only maintain uniform results in the test bars by having careful chemical analyses made.

Our test bars run about 25 percent stronger than those recommended by the American Foundrymen's Association, and we are only able to maintain these results by looking after the analysis very carefully.

METALLOGRAPHY APPLIED TO FOUNDRY PRACTICE.

PART III.

BY ALBERT SAUVEUR.

MICROSCOPICAL EXAMINATION OF PREPARED SAMPLES.

After a sample of cast iron has been polished and etched as described in the first two installments of this article it is ready to be examined under the microscope. The apparatus needed to carry on this examination will be briefly described.

The Microscope.—While any good microscope of the ordinary type may be used with some degree of success for the examination of samples of metal, a special stand as illustrated in Fig. 1 is almost a necessity for effective work. It differs from the ordinary type by the motion of the stage, which can be raised or lowered by rack and pinion mechanism. The advantage of this feature will be appreciated later on upon considering the illumination of the sample.

The microscope shown in Fig. 1 is manufactured by the Bausch & Lomb Optical Co., of Rochester, N. Y., and is the instrument universally used in the United States for the examination of metals. The microscopical outfit should include one low power objective (one-half or two-thirds of an inch focal length), one high power objective (one-sixth or one-eighth of an inch focal length) and two eye pieces, respectively of one-inch and two-inch focal

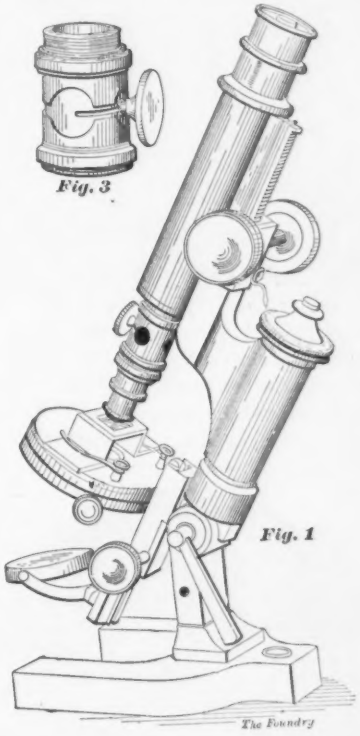


Fig. 3

Fig. 1

length. These will yield the different magnifications and resolutions which are needed for a successful examination of the structure of cast iron, it being very seldom that higher or lower magnifications are found necessary.

When examining a specimen of metal under the microscope it is absolutely necessary to bring the polished surface in a plane exactly perpendicular to the axis of the instrument, and unless some special device be used for holding the sample in this position this means that the polished surface and the opposite side must be exactly parallel, so that when the sample

rests upon the stage of the microscope, the upper surface will be in the proper position. The difficulty and labor implied by the cutting of two exactly parallel surfaces will be readily appreciated. To obviate this necessity the special specimen holder illustrated in Fig. 2 will be found most effective. A rubber band holds the specimen

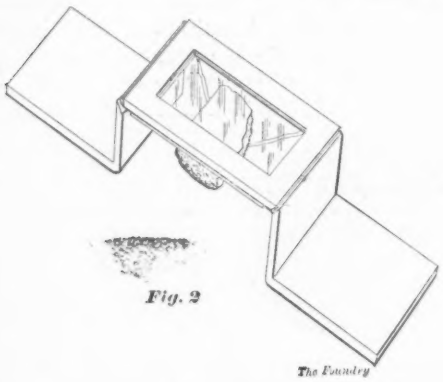


Fig. 2

The Foundry

firmly in the holder, however irregular in shape, and a cover glass may be inserted between it and the object so as to fulfill the requirements called for by the correction of the objectives. The holder is then placed on the stage where it can be clipped like any ordinary microscopic slide. (See Fig. 1.)

Reflected light, that is, light thrown from above upon the specimen must of necessity be used. This light may be reflected obliquely upon the specimen, directly from the source of light or with the assistance

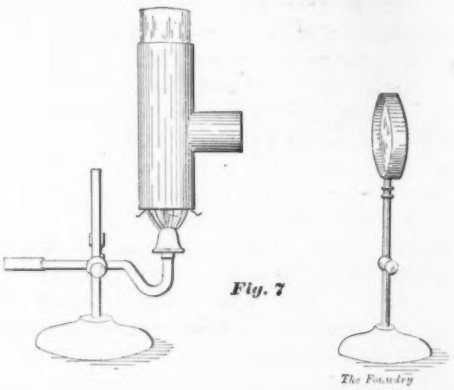


Fig. 7

The Foundry

of a mirror or of a condenser, or it may be reflected vertically upon the sample by the lenses themselves of the objective by means of a device known as a vertical illuminator and which affords by far the best illumination of opaque objects. This illuminator, which is shown in Fig. 3, consists of a small glass disc, supported by a milled head, which controls its position, and is inserted between the objective and the nose of the microscope, as shown in Fig. 1.

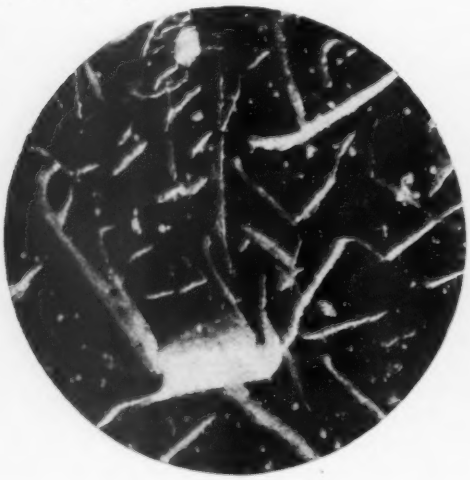


FIG. 4.

FIG. 5.

Illumination of the Sample.—Metallic samples are absolutely opaque objects and unlike the ordinary transparent slides of other microscopists cannot be illuminated by transmitted light, that is by light sent from below the stage through the object. The light from the source of light enters the illuminator through a lateral aperture and is reflected downwards by the little glass disc through the lenses of the objective, which condenses the light upon the sample. The light emitted by the lighted

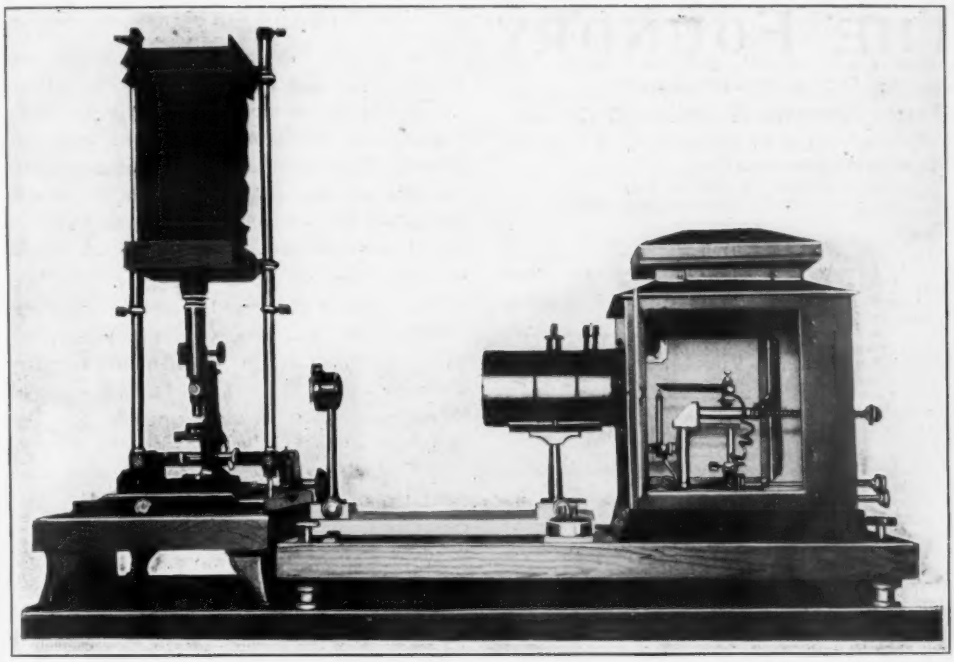


FIG. 6. SPECIAL ARC LAMP FOR OPAQUE OBJECTS.

portion of the specimen re-enters the objective, passes in part through the glass disc, then through the eye piece, reaching the eye of the observer and producing an enlarged image in the usual way.

Obliquely vs. Vertically Reflected Light.—It will readily be seen that obliquely reflected light can be used only with relatively low power objectives because high power lenses must be brought too close to the object to allow any beam of light to reach the latter from without. Obliquely reflected light, moreover, yields, so to speak, a negative image of the true appearance of the sample, because the bright constituents reflecting the light outside the microscope will appear dark, while the dark constituents, by absorbing and diffusing the light reflect some of it into the tube of the miscroscope and appear bright. Vertical illumination, on the contrary yields a true image of the appearance of the object.

In Figs. 4 and 5 are shown the structure of exactly the same spot of a sample of gray cast iron, but illuminated respectively with obliquely and vertically reflected light. It illustrates strikingly the opposite effects produced by these two kinds of illuminations. In Fig. 4 the plates of graphite appear bright, while they are black in Fig. 5, and therefore with their true color. The iron matrix on the contrary is dark in Fig. 4 and light in Fig. 5. In view of these considerations, it will be obvious that vertically reflected light is generally the best means of illuminating metallic samples.

Sources of Light.—Many artificial lights may be used to obtain a satisfactory illumination of metallic samples, but it will suffice to mention here the two sources which are most generally used, namely, the electric arc lamp and the Welsbach lamp. Fig. 6 illustrates a special arc lamp and accessories for the illumination of opaque objects. The outfit consists of an electric 90-degree arc lamp and rheostat, a triple condenser system, a cooling cell, an iris diaphragm and automatic shutter, an optical bench and base board. The illustration also shows the microscope connected with a camera for taking photomicrographs.

In Fig. 7 is seen a simple Welsbach lamp and condenser, an arrangement which yields a very satisfactory illumination for examination by low power objectives.

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PUBLISHED MONTHLY BY

THE PENTON PUBLISHING CO.

CLEVELAND, OHIO.

CHICAGO: 1164 Monadnock Blk.

PITTSBURG: 429 Park Bldg.

NEW YORK: 150 Nassau St.

The subscription price of THE FOUNDRY is $1.00 a year to points in the United States, Canada and Mexico. To Great Britain: Eight Shillings. Single copies 15 cents each.

Change of advertising copy must reach this office on the 10th inst. preceding date of publication.

The Cleveland News Company will supply the trade with THE FOUNDRY through the regular channels of the American News Co.

European Agents: The International News Company, Breams Building, Chancery Lane, London, E. C., England.

Practical articles pertaining to the trade in all its branches are solicited and will be paid for.

When sending in articles be sure to place your name and address on the article and on the drawings.

Entered as second-class matter at the Post-Office at Cleveland, Ohio.

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TRADE OUTLOOK.

The foundry business continues in the same healthy state that it was last month. Practically the same amount of metal is being melted and the same number of men employed. Most of the specialty foundries are working on long contracts which are usually let during the winter. The jobbing foundries report a continuance of a fairly good volume of business.

The price of pig iron has not changed materially. No. 2. Foundry at the Valley furnaces is held at $14.50. Most of the sales for the past month have been for rather small tonnages. No. 2 Foundry iron in the Birmingham district is selling for $12 per ton. The Chicago district, however, is finding some difficulty in obtaining prompt deliveries, these conditions being partially due to labor troubles in the South and partially due to the scarcity of cars. The furnaces in the Chicago district are also busy and local interests cannot look to them for any help and, hence, it is to be hoped that the transportation conditions will be improved, so as to give more prompt deliveries of Southern iron in the Chicago district.

The demand for foundry coke remains good and the price is quoted from $2.25 to $2.40 per ton at the ovens in the Connellsville region. In this connection it is interesting to note that a number of large by-product ovens are being built this summer. The Milwaukee Coke & Gas Co., is making very extensive additions to its plant, so that in a short time it will have 160 ovens in operation, and these will require approximately a half million tons of coal a year. The use of by-product coke for foundry purposes is constantly increasing.

Chemistry in British Foundries.

In Great Britain pig iron is still graded to a large extent by fracture, and comparatively few furnace companies will furnish iron of the guaranteed analysis. The British foundries, however, are waking up to the fact that if they are to maintain a uniform grade of castings they must mix by analyses and many of them are doing so. This will naturally lead to general chemical specifications for pig iron as it has in this country. In another part of this issue we publish an able paper on this subject. It was presented before the Cleveland (England) Society of Engineers by Mr. P. Munnoch of Middlesbrough.

This paper sets forth very plainly the condition of foundry work in Great Britain.

FOUNDRY AND PATTERN SHOP STANDARDS.*

BY WM. H. PARRY, BROOKLYN, N. Y.

It is an old maxim that molders and patternmakers never agree as to the means each should employ to facilitate the work of the other.

That this state of affairs will always exist, in spite of the well-meaning action of societies in appointing standardizing committees, cannot be denied, but by this very action, a much better basis of understanding can be brought about. The conditions which surround each of the interested parties will be better known, and thus a start in the right direction made.

When we speak of standardizing everything in foundry and patternshop, it is not to be by means of hard and fast rules, for this is bound to fail, because of the constantly varying conditions along these lines of mechanical endeavor. Much, however, can be done by the observance of the fundamental principles that govern a fair proportion of the work accomplished in both departments of the industry.

In loam work it is often found that a wide divergence of opinion exists on many points pertaining to that branch of the foundry trade. Chief of these may be mentioned the proper angle of the sides of in-and-outside seats, their depth, and the diameter of spindles used. Some foundrymen insist on having sweeps made for seat plates, such that for every inch of depth, one-eighth inch angle must be allowed. This certainly shows good results. Other foundrymen, however, insist on having but one-sixteenth inch for this purpose. Still others demand three-sixteenths of an inch, and the severely technical foundry superintendents are still abroad who require their angle given in degrees and minutes. Yea, sometimes even in seconds.

Now this is all very pretty, but unfortunately it adds to the already chaotic conditions of the shop. Right here it is suggested that from an all around experience of many years, one-eighth of an inch is about the proper angle.

Next we have the old controversy of the depth of core and outside seat. The ratios differ from one inch in depth of seat to one foot in height of casting, regardless of diameter; to one-half inch of depth to one foot of height. This can easily be settled by simple formulae which suggest themselves, and have been in successful use for some years. For instance, with the diameter D, and the height H, the formula

$$\frac{D + H}{2} = Y$$

is applicable for castings approximately equal as to height and diameter, and

$$\frac{D + H}{4} = Z$$

is applicable where the diameter is twice the height. It can readily be seen that sufficient area of contact is given to insure rigidity and proper alignment.

The diameters of loam spindles are rarely the same in any two jobbing foundries, often varying from one and one-half to four inches in diameter; and to suit these deplorable conditions sweeps are made by the patternmaker to the center line, with the understanding that the foundryman will trim them to suit the size of the spindle. It works fairly well for a time, though it increases the foundry cost and offers a fine field for incorrect work for the first molder, not to speak of the next one who tackles the job, and whose spindle is a little larger or a little smaller than the one used by the first man.

It may be difficult to standardize matters here, but at least to evoke discussion it is suggested that for castings whose diameter and height do not exceed five feet, a two inch spindle should be used. Over five and under ten feet, use a three inch spindle; over ten and under fifteen feet, a four inch spindle, or some sort of an arrangement of this kind which will give the patternmaker a line on which to work, so that he can make his sweeps and loose pieces accordingly, and not thrust work upon the foundryman, which should be done in the pattern shop in the first place.

The question of draft has undoubtedly been a bone of contention from the very beginning of the art of making patterns and casting metals. It does seem that an agreement can be reached between the disciples of both trades, if a proper spirit is manifested. If the spirit of give and take be manifested, a rule can surely be agreed upon, such for instance that one degree

*Paper read at A. F. A. convention, New York city, June, 1905.

of draft be always allowed for drag and cheek, and never less than three degrees for cope. What an advance there would be in the right direction, if this were an accomplished fact, to say nothing of the clearing of the atmosphere about the foundry when such things as back draft, no draft, or very little draft, come up for ventilation.

The angle of the sides of core prints is a point worthy of our serious discussion, as there are but few foundries and pattern shops wherein there is an agreement on that matter. For all around work this angle varies from five to fifteen degrees a side. In this age of core-making machines there seems to be a peculiarly opportune time to make a stand for what in the estimation of the members of the American Foundrymen's Association, is the right angle for all cope prints, whether they are small enough to make on the machine, or big enough to be made by strickles. The angle should be determined for all time.

The molding machine has come to stay, and to keep up with the procession, the size of flasks to be used on standard makes is, and is going to be, a serious problem for the patternmaker who has to fit up work for different styles of machines, whose flask sizes differ as well. There should be standard flask sizes, such as 10" x 10", 12" x 12", 12" x 18", 12" x 24", etc. etc. By this arrangement patterns could be fitted up in one city, and cast in another. The fitting up of patterns at the foundry would be obviated, whereas this must now be done on account of the many manufacturers of molding machines.

Mechanical engineers, who decorate their drawings with mandatory orders to cast *off* this, or two *of* this, or sometimes two *as* this, apparently need a little help in the ordering of castings. So why not simplify the matter by using symbols, to which they are proverbially prone, say such as Ct 2, and thus destroy at one fell swoop the everlasting controversy whether it is two off, of, or as. Again, if two castings are to be made from the same pattern, so made that by the transposition of a loose piece or two, it makes right hand or left hand work, they might instead of the usual instructions to Cast One Right and One Left, use the same symbols, Ct 2 R & L, or Ct 1P, which being interpreted means Cast One Pair. In this way less time is consumed in writing orders for castings, and an understanding is also reached between foundry and pattern shop.

The varnishing of patterns so that prints show a contrasting color, and spots sometimes occupied by loose pieces also show still another contrasting color, is, so far as the pattern shop is concerned, a very pretty way of decorating a pattern. The trouble is, that after making a few castings all colors look alike, and it has happened that a loose piece has been forgotten here and there, and consequently costly castings have been returned minus these protuberances, all because the molder of the pattern may have been color-blind. If, instead of contrasting colors, the prints are stamped *Print,* loose pieces, and the spaces they belong to, stamped L. P. 1, L. P. 2, L. P. 3, L. P. 4; and finished surfaces F. F. F., care being taken never to use the letter F to designate a loose piece; it will be found that better castings result with less pattern shop expense.

There are many other practices that could be improved upon by standardizing and it is to be hoped that patternmakers and foundrymen alike will cast their prejudices aside and thus make it possible for both to dwell in harmony in the future. For this purpose I respectfully request that a committee be appointed by this Association to study the standardizing of patternshop and foundry practices, and report recommendations from time to time to this body.

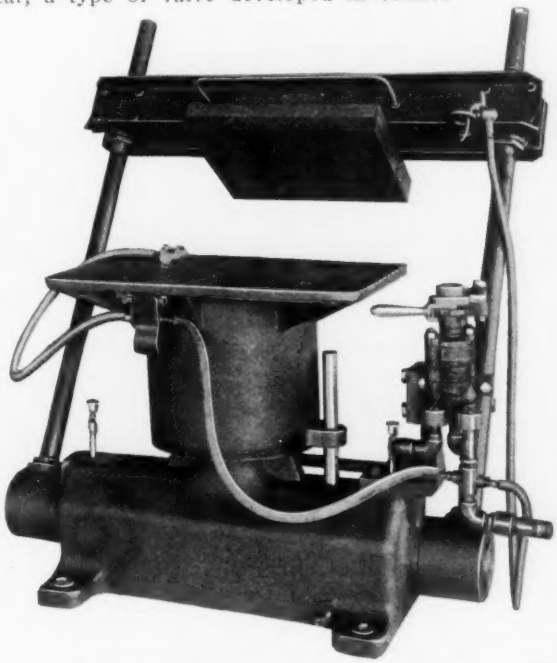
NEW MOLDING MACHINES.

Success in any line of manufacture depends to a large extent upon experience in the past which enables the engineer to overcome difficulties encountered and produce mechanism whose reliability and efficiency are in direct proportion to his experience in the application of his mechanism to its practical work.

The accompanying illustration shows one of the first of a complete line of molding machines recently brought out by The E. H. Mumford Co., of Philadelphia, Pa., which embodies a number of radically new and good features.

It is a simple power-ramming machine with 3 ft. in the clear between strain rods and a 12-in. cylinder for ramming. The

strain rods of the machine are of heavy tubing, insuring at once lightness and strength with exceptional stiffness. The joints of the trunnion shaft at the base, which of necessity work in the sand, are protected by wiper rings, absolutely precluding the entrance of sand to the bearings. The counterbalance spring which aids in the swinging of the ramming yoke up and back is housed in the base of the machine away from all sand clogging, and this construction avoids all projections of counterweights, spring boxes, etc., which are in the way and catch sand. The main throttle valve of the machine is the well known "Motorman's" valve of the trolley car, a type of valve developed in connection with air brake service, where the tightest and the most reliable valves are absolutely essential.



This machine is intended for that class of work in which loose patterns or patterns attached to plates or gates are used without further attachment to the machine, and the vibrator for attachment to such patterns in various ways is shown lying on the table.

In connection with this machine the Lovell pattern draft apparatus is used. This apparatus affords an unguided vertical vibrator lift for, the loose pattern from the drag flask, the guide for the pattern being furnished by a separate guide frame reaching the pattern at the joint with contact so perfect that patterns once drawn may be returned to the mold with absolute precision. The cope half of the mold is lifted while a base plate on the machine is vibrated by separate vibrators operated by the knee valve shown at the front of the machine.

This Lovell pattern draft apparatus will form the subject of a later article, as it is distinctly novel in itself and avoids not only the expense but the springing and breaking of more or less rigid attachments to the patterns.

HARD CAST IRON.

I have read with much interest the paper on "Hard Cast Iron," by Mr. Henry Souther, published in the August number of *The Foundry*. It suggests a somewhat similar experience of my own with a very different class of castings, viz.: cast iron pipe. Pipe, as every one knows, are made in twelve foot lengths, cast on end and poured from the top; and this allows any impurities in the metal to rise to the top of the mold and lodge in the bead or small end of the pipe.

Some time ago a gate broken from a pipe was brought me that showed in fracture a number of small brownish-red spots that looked something like little patches of iron ore. An examination of the pipe from which the gate was broken revealed the same appearance in the bead. Afterwards this "dirty iron" was observed in the beads of a good many pipe and it caused considerable trouble. The reddish color spoken of showed only on a hot fracture or where the surface of the metal had been exposed to the air in cooling; otherwise the fracture was of a dull gray cast, but the presence of the foreign substance could be plainly seen and where much of it was present it could be knocked out like so much sand. Repeated analyses were made of this material, including tests for copper, titanium and arsenic, but without any very definite result. It was suggested by someone that burnt or rusty scrap might be the cause of the trouble, but we use no burnt scrap and very little scrap of any kind. Another explanation

which I heard at this time was that the reddish substance we saw was "unreduced ore," which owing to a slip of the burden in the blast furnace had come down into the hearth before its time and that the pig iron was consequently raw. It seemed to me that if enough unreduced ore got into the pig iron to cause our trouble it ought to show in the fracture of the pig, but it didn't. Moreover an analysis of this substance for iron showed it to be altogether too high in this element for iron ore. Besides it seemed probable that iron ore would be carried off in the slag in melting in the cupola. Finally the various brands of pig iron in use were tried separately, as far as practicable, and the trouble narrowed down to two or three brands of iron low in manganese, say under .25 percent. The manganese in our castings while having this trouble ran about .25 to .35 percent, which I did not consider out of the way at the time. By raising the manganese somewhat, say to .50 percent, the trouble was overcome. The use of the low manganese pig irons was continued, and has been right along, only care is taken to mix enough higher manganese pig with them to get the desired percentage in the castings. The low manganese pig we were using at the time spoken of happened to be Alabama iron, but I have heard of exactly the same trouble being encountered with low manganese iron made from Lake Superior ores and from New Jersey ores; in all cases the remedy was the same. It might be well to add that this "dirty iron" was much more evident in heavy than in light pipe, doubtless due to the fact that in the heavy pipe the metal remained fluid longer and gave a better chance for its separation.

In the instance cited by Mr. Souther, where the iron appeared to be gritty, I believe the trouble was due to the same cause as in the case just described. The fact that nothing unusual could be seen in the fracture very likely being due to the size and shape of the casting, which probably allowed little chance for the separation of the impurity from the body of the iron. I believe also that this is the cause of many castings checking, or cracking hot, from shrinkage strains; and it is well known that such trouble can often be overcome by an extra dose of manganese. As to the precise nature of the substance described, and how it is formed, I am not at all satisfied. Mr. Souther suggests a carbide of iron or carbide of silicon. I think more likely that it is a mixture of silica—formed from the silicon in the iron—and partially oxidized iron and that this burning of the iron takes place in the cupola in the absence of the suitable amount of manganese.

F. T. WRIGHT.

USE OF FERRO-MANGANESE AND FERRO-SILICON IN THE LADLE.

These tests were made as the result of a number of defective castings poured after using 80 percent ferro-manganese in the ladle; the castings all contain a series of blow holes on the inside at the bottom against a large core. Different mixtures were tried, the coke changed, the core and mold vented as much as possible, and ferro-silicon used, but to no advantage except in the last instance when the defect was corrected to a large extent. Three bars were first cast; of the metal from cupola; metal plus 80 percent ferro-manganese; and plus equal amounts of manganese and 50 percent ferro-silicon. The first came out a good solid bar, the second filled with holes and the third contained similar marks but to a much less extent.

Six bars (purposely of high S iron) were then cast, 1½ in. square by 2 ft. long, as the castings were rather large. Bar No. 1 was of cupola iron, bar No. 2 was of same iron plus 1 oz. 80 percent ferro-manganese, No. 3 same iron plus 2 oz., No. 4 plus 4 oz., No. 5 plus 6 oz., and No. 6 plus 8 oz. The manganese contents were increased by these amounts approximately (in theory) .26 percent per oz. added. The manganese was fine enough to pass through a 30-mesh sieve, was put in the ladle, the iron poured in on it and stirred vigorously. Owing to the large amount of alloy used and on account of the metal being hotter No. 6 was poured first, then each bar as the amount of alloy added decreased. The iron was as uniform as possible, tapped into a large hand ladle from which all the small ladles were poured.

When No. 6 was poured a thick gummy mixture of shot-like iron and slag arose, sticking wherever it struck, and on each ladle containing manganese appeared the same formation but in smaller amount as the manganese de-

creased. No. 1 was practically free from it. This gummy mixture had been noticed in all ladles having manganese added in the defective castings.

The bars were to all appearances perfectly sound, but in being machined (to exact size to get comparative results), No. 1 showed a good casting but extremely soft; all of the others machined soft but in each appeared the blow holes (or pit marks), increasing in size and number in proportion to manganese added.

The bars were then subjected to transverse strength and deflection tests with following results:

	Broke at Lbs.	Deflection in Inches.
No. 1	3,880	.437
" 2	3,340	.375
" 3	3,460	.368
" 4	3,605	.360
" 5	3,750	.343
" 6	3,590	.343

In silicon and phosphorus contents the bars ran practically the same; Si = 1.67 (1.71 to 1.63); P = .434 (.428 to .440); but for Mn, S, and carbons the following were the results:

	S	Mn	C. C.	Gr. C.	Total.
No. 1	.145	.48	.48	2.58	3.06
" 2	.135	.58	.51	2.63	3.14
" 3	.107	.81	.59	2.63	3.22
" 4	.091	1.05	.72	2.64	3.36
" 5	.088	1.07	.52	2.72	3.24
" 6	.093	1.07	.58	2.52	3.10

The increase of total carbon is evidently due to the high percentage of carbon, the Mn contained about 5 percent, though the decrease in numbers 5 and 6 cannot be accounted for.

The slag freed from its 37 percent magnetic iron when analyzed for Mn and S gave:

Mn = 3.26
S = .868

It was concluded from above data that: (1) Mn is (as always claimed for it) a desulphurizer, but that the addition of 1 percent in the ladle accomplishes the same result as 2 percent; (2) but a portion of the Mn is assimilated by the iron in the ladle—maximum percent of the amount added when 1 percent is used; (3) the addition of Mn in the ladle promotes a pit or blow hole; (4) the metal is weakened by these holes, though an increase of Mn up to 1½ percent tends to overcome this weakness; (5) angle of deflections varies inversely as Mn added; (6) the strengthening of iron by Mn (and softening as some claim for it up to certain percents) is accomplished through the elimination of sulphur, and (7) to harden iron by Mn it must be so added as to compound with the iron.

Also, since castings made by omitting ferro-manganese came out good and solid, the use of this alloy for this class of work (cylinders) is detrimental and if desulphurization is desired sufficient ferro-silicon should be used (where practical) to overcome the Mn effects.

Since the above article has been written the Mn contents of castings has been increased to desired point with perfect results by melting with the charge in the cupola a 3 percent manganese pig iron.

Four test bars were cast, 1½" square by 2 ft. long and machined to exact size. No. 4, on account of the metal being hotter and larger quantity of alloy used, was poured first, and No. 1 last. To No. 4 was added 2 oz. 50% ferro-silicon and 1 oz. 80% ferro-manganese, both crushed fine enough to pass through a 50 mesh sieve; No. 3 2 oz. ferro-silicon; No. 2 1 oz. and No. 1 was cupola metal. The silicon contents were increased approximately .2% per oz., added and manganese .26% per oz.

The bars all came out good and solid except for a few dirt holes in No. 3; there were no pit marks as in test bars for manganese, and no such gummy slag, though No. 4 had more slag than any other. When machined all worked medium soft, No. 4 being, if anything, a little harder than the rest; and when broken all gave a nice close grained iron.

When subjected to transverse and deflection tests the following results were obtained:

	Broke at Lbs.	Angle.
No. 1	3280	.375"
No. 2	3584	.375"
No. 3	3642	.375"
No. 4	3264	.375"

When analyzed the bars showed the following composition:

	No. 1.	No. 2.	No. 3.	No. 4.
Si	2.81	2.93	3.04	2.99
S	.103	.098	.101	.091
P	.421	.433	.426	.429
Mn	.34	.34	.36	.45
Gr.C	2.69	2.65	2.78	2.73
C.C	.54	.60	.55	.61
T.C	3.23	3.25	3.33	3.34

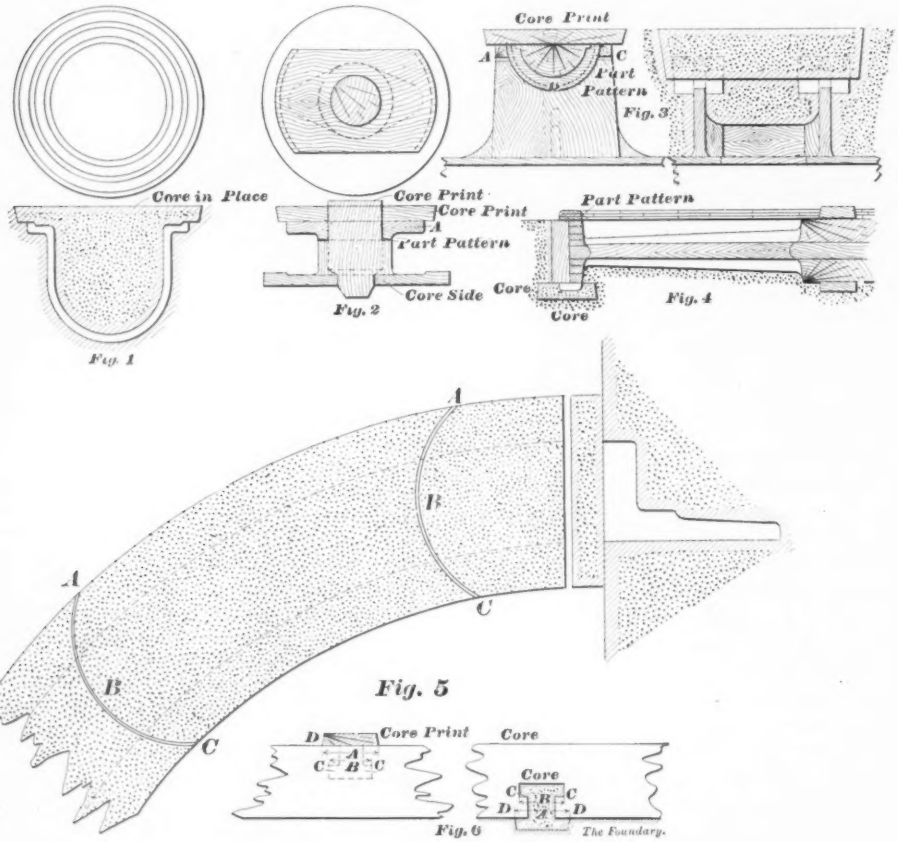
From this date it appears that ferro-silicon in the ladle is beneficial to castings in quantities sufficiently small as not to increase the softness of the metal to an appreciable extent, and that the only advantage gained by using manganese is a reduction of the sulphur.—Chemist.

THE USE OF COVERING CORES.

BY H. J. MCCASLIN.

There are an infinite number of ways in which covering cores can be used and hence only a few can be shown in a single article, but the accompanying illustrations cover the principal uses of this class of cores. Covering cores are also frequently called slab cores, and can frequently be set without the aid of a core print. The adoption of the covering core frequently saves a three-part flask, or the adoption of a more intricate cored mold and expensive patterns. In some cases, especially in a deep setting, the covering core may be objected to by some foundrymen, on account of the difficulty of removing any sand which may fall into the mold during the drawing of the pattern. When the covering core is used in the cope, this objectionable feature is done away with, as the core may be placed in the depression left by the core print previous to or after the closing of the mold. When the core is used in this way, of course it is inserted through the cope and weighted or wedged down. The application of a covering core to the mold for a casing or hood is shown in Fig. 1. In this casting there is a very light metal thickness and the advantage of the suspended core in regard to venting and also setting, in the production of a sound casting will be readily seen.

The molding of such a piece as this with the ordinary dry sand core would usually make it necessary to cast or mold the piece in a reverse position and this would not, as a rule, give good results. When a metal pattern is used which leaves its own core it is possible to mold the bowl in a reverse position successfully. A cylinder head and stuffing-box pattern are shown in Fig. 2, together with a core print for the covering core attached. This arrangement gives a very simple pattern and mold. The core print is drawn, together with a part of the pattern A, during the ramming



up of the mold, and the slab core interposed in place of the core print. The ramming of the mold is then completed by the ordinary method. This is described and illustrated more fully in the next example.

The covering core method as applied to the double bearing is illustrated in Fig. 3. At the left is shown the end view of the bracket portion of the pattern, illustrating the general construction of the bracket and showing the parting line A B C. At the right is shown a longitudinal section of the partially completed mold with the covering core in place. In making the mold the pattern is placed upon the board and rammed up to the top of the core print in the ordinary manner. The core print, with a portion of the bearing above the line A B C, is next withdrawn from the sand and the covering core placed in the depression left by the core print. The balance of the flask is now rammed up, struck off and rolled over in the ordinary manner. The cope is then placed in position, the ramming completed, and the balance of pattern drawn as usual.

The covering core as applied to a shrouded gear is shown in Fig. 4. The illustrations show the pattern rammed up with the core in place and the flask rolled over ready for placing the cope in position.

Many circular pieces of work in the foundry can be covered with slab cores to save the ramming up of the cope. This method is shown in Fig. 5. Usually the ends of the cores radiate to the center. Unless they are made to the proper diameter the ends will not fit together without filing and fitting of the cores. As these cores are frequently kept in stock, they are a source of much trouble to the molder. This trouble can be readily done away with by making the end of one core convex and the corresponding one concave, as shown in Fig. 5, where the curved line A B C represents the junction between the adjacent cores. By this arrangement the ends of the cores can be kept together while they are adjusted for almost any radius of mold.

The use of chaplets for holding down the cores in floor plates, etc., is generally a source of considerable trouble, but this difficulty may be done away with by constructing the cores as shown in Fig. 6. At the left is shown the pattern with a core print attached and the outline of the core shown by dotted lines. To the right is shown a cross section of the mold, with the core in place.

It will be noticed that the core print is wider than the head of the T slot and hence when a core of this section is set into the depression made by the core print and the metal flows into the mold, there will be more area exposed to the metal along the width A than along the width B, in other words, the surfaces D are wider than the surfaces C, hence the metal which exerts a lifting force along the overhanging portions C will be more than balanced by the metal bearing down on the portion D. With cores made and set in this manner, no chaplets are necessary.

ACCOUNTING. — AN INFLUENCE TOWARDS LESSENING COSTS AND INCREASED EFFICIENCY.*

BY KENNETH FALCONER, MONTREAL, P. Q.

Lincoln once said, "If we could first know where we are, and whither we are tending, we could better judge what to do, and how to do it."

Possibly he was referring to some problem which he had personally met with in relation to Cabinet making—possibly he was addressing a convention of foundrymen. His words, however, indicate the real usefulness and value of special methods of factory or foundry accounting, designed with regard to the peculiar nature of the business to which they are to be applied. To show where we are, and whither we are tending is very generally regarded as being altogether an accounting proposition, but to know to the detail necessary in these days of close competition, the ordinary work of the accounting department must be supplemented by the work of those more closely connected with the productive operations of the business. To record in detail the exact standing of each department, as well as the entire organization, to show the individual result of each of the thousand and one influences, which in a manufacturing business make for success or failure, betterment or inefficiency, in any department is not the work of the accountant alone, nor of the manager or engineer alone. It is a combined field of accounting and detail of management and is an executive department in itself.

One of the first steps in devising a proper system of factory accounting, of which cost finding is such an important detail, whether in relation to the manufacture of castings or the making of any other product, is to divide

*Paper read at A. F. A. Convention, New York city, June, 1905.

the organization into its component departments, and to provide that the operations and transactions of each may be intelligently recorded, and the results of such operations and transactions clearly defined.

While it is impossible to lay down any general rule on this subject, the best primary lines of division will usually be to classify the departments as productive, selling and general. Of the productive departments, some may be what may be termed "indirectly productive," others actually productive in the sense of receiving raw or partly manufactured material, and delivering such material in a further or completed state of manufacture.

Another point in planning methods of accounting is a very clear determination of the results to be sought in the case of each department, the use to which such results will be put, and the value which it is hoped to secure by such use. If, before the general scheme is determined upon, these points are thoroughly considered, it will frequently result in the elimination of useless work and records, and the avoidance of duplication of work, by using the same original records as the basis of two distinct lines of information.

Having defined the departments into which the organization is to be divided, having clearly outlined the information it is desired to secure, and the use to which such information will be put, the problem practically resolves itself into as many sections as there are departments. While in a manufacturing plant many of the departments may often be treated on the same lines, yet, on the other hand it is frequently the case that the methods applicable to one would not secure the best results in another; that means perfectly legitimate in one case may be illogical and absurd in the very next department. For instance—as regards the distribution of indirect expenses, a very general practice is to distribute them in some established ratio which they may bear to labor, either as a percentage, or on an hourly basis. While this may be generally correct, under some circumstances there is no distinct relation between these two factors, and some other known factor of the business, possibly machine hours, possibly weight or measurement of output, should be adopted as the basis on which to apportion indirect manufacturing expenses.

In connection with factory or foundry accounting, to know whither we are tending means much more than merely knowing whether the ultimate result is progress or retrogression. Progress or decay in an industrial organization is the final result of many different influences of varying strength and weight. Some are for, and some against success—some are direct and some are indirect. To show the tendency of each one of these influences, to record whether they are increasing or decreasing in force, and the effect of any line of action intended to strengthen or weaken any of these forces; to show the final results of each, and clearly indicate the relation between cause and effect, between influence and result, more than justifies the expenses involved in installing and preparing a proper system of accounting. Like other details of management, the real test of the worth of such work lies in the dollar and cent value of its results.

Accuracy of results is a prime essential of the work of any accounting department, but promptness in securing such results is of almost equal importance in relation to factory or foundry accounting. The interest of the management, even in important information depends largely on the promptness with which such information is furnished; the value of such information to the management as an influence towards lessened costs, or increased efficiency decreases in an ever growing ratio with each day that passes between the close of the period referred to, and the date that the information is available for examination and study.

Much of the value of many otherwise efficient systems of factory accounting and cost finding is lost by failure to so tabulate the information secured, as to most graphically bring out its salient and important points. Apart from the question of the relative advantages of figures, curves and diagrams, it will often be found that records apparently unimportant in themselves, may convey very important meaning if shown, not in comparison with similar records of preceding periods, but in conjunction with data of related interest during the same period.

Accounting in the ordinary sense is the science of securing certain records and information, irrespective of their further use, and the ordinary work of the accountant is complete and finished in itself. Factory accounting has been defined to be the science of securing, verifying and recording the operations and transactions of a productive organization, in such manner as to afford a basis for judicious action and prudent decisions regarding its future conduct. Although complete and

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finished in itself does not in itself represent its own entire value. It should be the basis of cost reduction, the ground of improved efficiency, and unless it is, it fails of the very purpose which justifies its existence. Accounting is a passive system of records, factory accounting an active influence towards success.

Methods of accounting, whether designed for a factory or a foundry, on the lines I have tried to indicate—recording where we are to the detail, and to the manner which I have tried to point out—showing whither we are tending, not as regards to final result, but as regards each separate influence, and each separate department will supply to the management a basis for their very best judgment, and be in itself a direct influence towards the ultimate success of the entire organization. There are a thousand and one influences in every manufacturing plant, which make in some degree for success or failure, for betterment or retrogression of some one or more departments. To know absolutely the result of each of these is one of the best possible means of guarding against them, or of strengthening them according to the nature of their influence.

SLAGGING A CUPOLA.

BY DAVID ROGERS.

I have sought since becoming a reader of *The Foundry* some definite statements regarding the quantity of limestone required to form a slag in the cupola, but have met with statements the most of which are nothing more than guesses. One party uses limestone on the first charge, another on the sixth, and so on, each varying the amount used. In this article I shall try to explain how this troublesome question can be reduced to a system, just as the subject of mixing iron by analysis has been.

The slags, or silicates, as they should be termed, conform to one or more of the following formulae, in which RO is supposed to represent the metallic or other oxide compounded with the silicate.

$4\ RO + SiO_2 = R_4\ SiO_6$, a subsilicate.
$2\ RO + SiO_2 = R_2\ SiO_4$, a monosilicate.
$RO + SiO_2 = RSiO_3$, a bisilicate.

The bases which correspond to RO are lime (CaO) and magnesia (MgO). There are other bases, the oxides of which correspond to the formula R_2O_3. The most common base in this group is aluminum, the oxide of which is alumina (Al_2O_3) For these bases the reactions are:

$4\ R_2O_3 + 3\ SiO_2 = R_8Si_3O_{18}$, a subsilicate.
$2\ R_2O_3 + 3\ SiO_2 = R_4Si_3O_{12}$, a monosilicate.
$R_2O_3 + 3\ SiO_2 = R_2Si_3O_9$, a bisilicate.

The quantities of oxygen in the base bear the following proportions to those in the acid in the above silicates.

	Oxygen in Base.	Oxygen in Acid.
Subsilicate	2	1
Monosilicate	1	1
Bisilicate	1	2

It is from the proportions of oxygen in the base and acid that the prefixes sub, mono and bi are derived.

The sub-silicates are easily fusible, forming a limpid slag. They consolidate very readily and split up in so doing. They usually have a dark color and on account of the large percentage of bases they have a high specific gravity.

The behavior of the cupola slags and also the consideration of the comparatively low temperature attainable in the cupola indicates that their composition is approximately that of the sub-silicate described above.

For the following calculations I have selected a coke of average quality which contained 10 percent of ash, the analysis of the ash being as follows:

Fe_2O_3	Al_2O_3	CaO	MgO	SiO_2	S
0.28	4.4	0.2	0.1	4.8	1.0

The limestone used has the following analysis:

CaO	MgO	CO_2	SiO_2	Al_2O_3	Fe_2O_3
49.75	2.08	41.20	5.17	0.69	0.83

The high percentage of silica (SiO_2) in the limestone will serve to demonstrate the necessity of having pure materials. It is first necessary to see to what extent the ash in the coke is self fluxing. Calculating from the molecular weights in the proportion suitable to form a sub-silicate, we obtain the following results:

Formulae	Molecular Weights	Bases
$4\ Fe_2O_3 + 3\ SiO_2 = 640 : 180$	:: 0.28	: X=0.07
$4\ Al_2O_3 + 3\ SiO_2 = 411 : 180$	:: 4.4	: X=1.92
$4\ CaO + SiO_2 = 224 : 60$	:: 0.2	: X=0.05
$4\ MgO + SiO_2 = 160 : 60$	:: 0.1	: X=0.03
		2.07

Silicon fluxed by bases present, 2.07.

In other words, 2.07 percent of the silicon is fluxed by the bases present. Deducting this quantity of silica from that present in the coke, we have $4.8 - 2.07 = 2.73$, to be fluxed

by the lime, CaO. This gives the following equation:

$$SiO_2 + 4\,CaO = 60 : 224 :: 2.73 : X$$

Solving for X we find X = 10.19, which is the precentage of CaO required.

It is also well to allow a little limestone to extract the sulphur. This equation on the basis of S + CaO becomes 32:56::1:X. Solving for X we obtain 1.75 as the percentage of lime to be used. This gives a total of 10.19 + 1.75 = 11.94 as the percentage of lime or pounds of lime to be used to every 100 pounds of coke.

The limestone given above is not pure and hence it is necessary to use a sufficient amount to obtain the desired amount of calcium oxide. It is necessary next to determine to what extent the limestone is self-fluxing, as it contains 5.17 percent silica (SiO_2), which is a very serious item. The following table gives these calculations.

Formula	Mol. Wts.	Bases other than CaO	X
$4\,MgO + SiO_2 =$	160:60	:: 2:08	: X = 0.81
$4\,Al_2O_3 + 3SiO_2 =$	411.2:180	:: 0.69	: X = 0 03
$4\,Fe_2O_3 + 3SiO_2 =$	640:180	:: 0 83	: X = 0 23
Silica fluxed by bases other than CaO =			1.07

Subtracting this from the total amount of silica we have 5.17 — 1.07 = 4.1 silca (SiO_2) to be fluxed by the lime (CaO) in the limestone.

Calculating as above, we have:

Formula	Mol. Wts.	SiO CaO
$SiO_2 + 4\,CaO =$	60:224 ::	4.1 : X

Solving, X = 15:30

This leaves for effective work in a limestone containing 49.75 CaO, only 34.45 percent CaO. The other item in the analysis is the carbon dioxide, CO_2 and this does not enter into the slag but escapes as a gas. From this we see that for every 100 pounds of coke we should want 10.19 + 1.75 = 11.94 parts of pure lime, that is, CaO. Our calculations have shown that in our 100 pounds of limestone there are only available 34.45 parts of lime, and hence it will be necessary to calculate the amount of limestone required, as follows:

34.45 : 100 :: 11.94 : X, in which X equals 34.65.

From this we see that in the case chosen for every 100 pounds of coke we must use 34.65 pounds of limestone.

The sand on the pig iron, sprues, gates, etc., would necessitate a still larger addition. If there is not lime enough present to satisfy the silica, it will unite with some of the iron, and limestone is certainly a cheaper flux than metallic iron. In conclusion I may say that there are slide rules and other appliances in use by which these calculations can be made very quickly.

W. J. KEEP'S SECTIONAL CUPOLA.

The difficulty in cleaning and repairing the lining of small cupolas has prevented their general use.

In emergencies, such a cupola would be a very great convenience, if it could be easily managed.

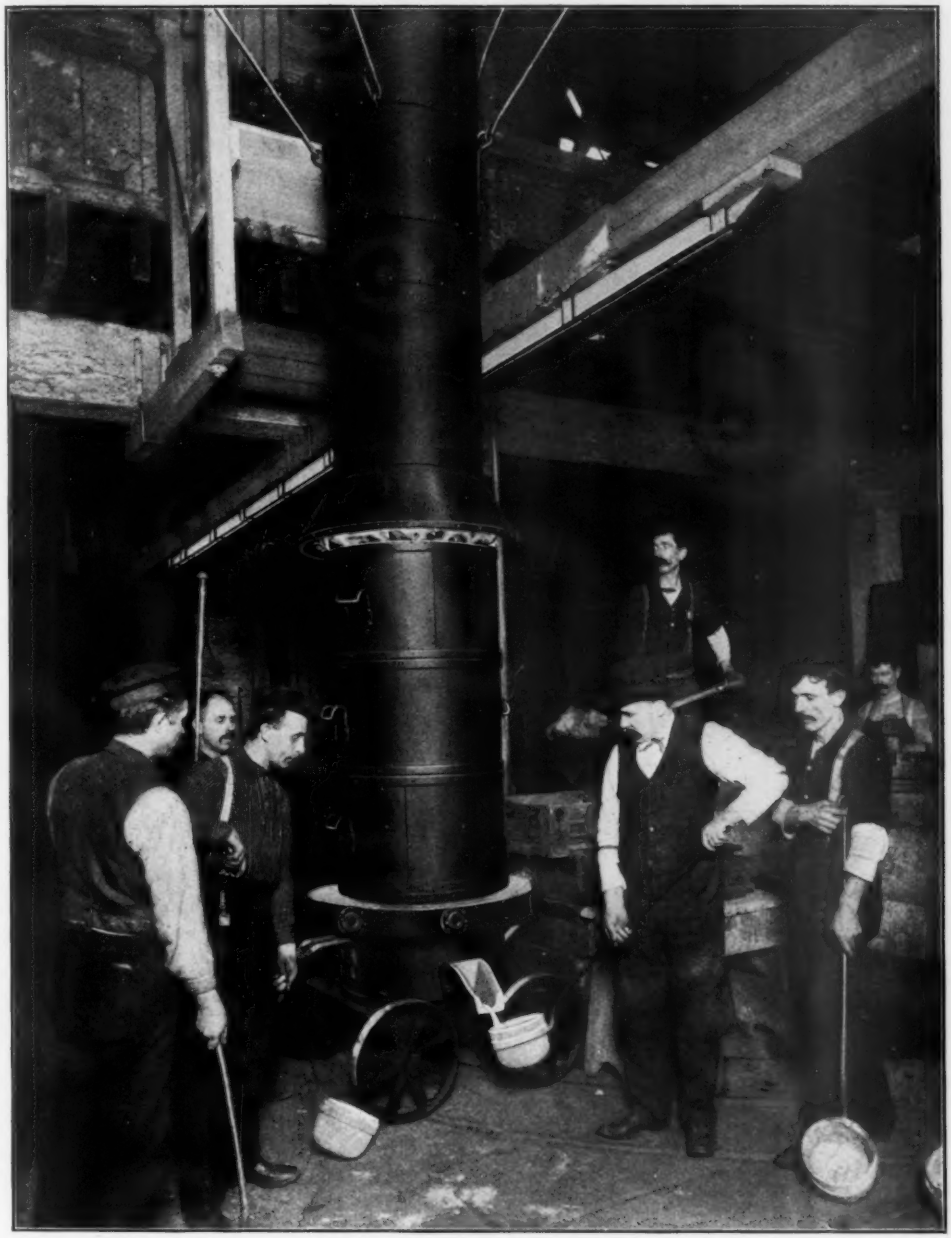
Mr. Keep's cupola is made in sections, 18 inches long and 28 inches outside diameter. These are lined with ordinary stock brick laid flatwise, the edges being beveled to key the bricks in. The complete lining is three inches thick, making the inside diameter 22 inches. A ring of one and one-half inch angle iron is riveted to both ends of each section for stiffness, to hold the brick in place and to make a joint between sections. The lower section contains a wind box and six tuyeres, four and one-half inches square on the inside. This section is set on a solid bedplate on wheels, so that the cupola can be rolled anywhere required. The sections can be handled by a light jib crane or by a trolley, placed a little to one side of the stack and with an ordinary chain hoist.

The stack is suspended by rods from the foundry roof; is 24 inches in diameter, and flares at the lower end to 36 inches. The lower end is seven feet six inches from the floor, and is just high enough for the cupola to roll under it. One side of the flaring portion is cut away for a charging door. The three-inch opening between the top of the cupola and the edge of the stack creates a strong draft and keeps the air fresh around the cupola.

It is best to repair a lining before the heat is required so as to save delay when a heat is needed.

To Take off a Heat.

Roll the bedplate under the trolley track, and put the lower section in place. Put in the sand bottom two and one-half inches thick at the front and three and one-half inches at the back. Line the spout; put in the breast and make a slag hole at the rear. Lay shavings and kindlings in this

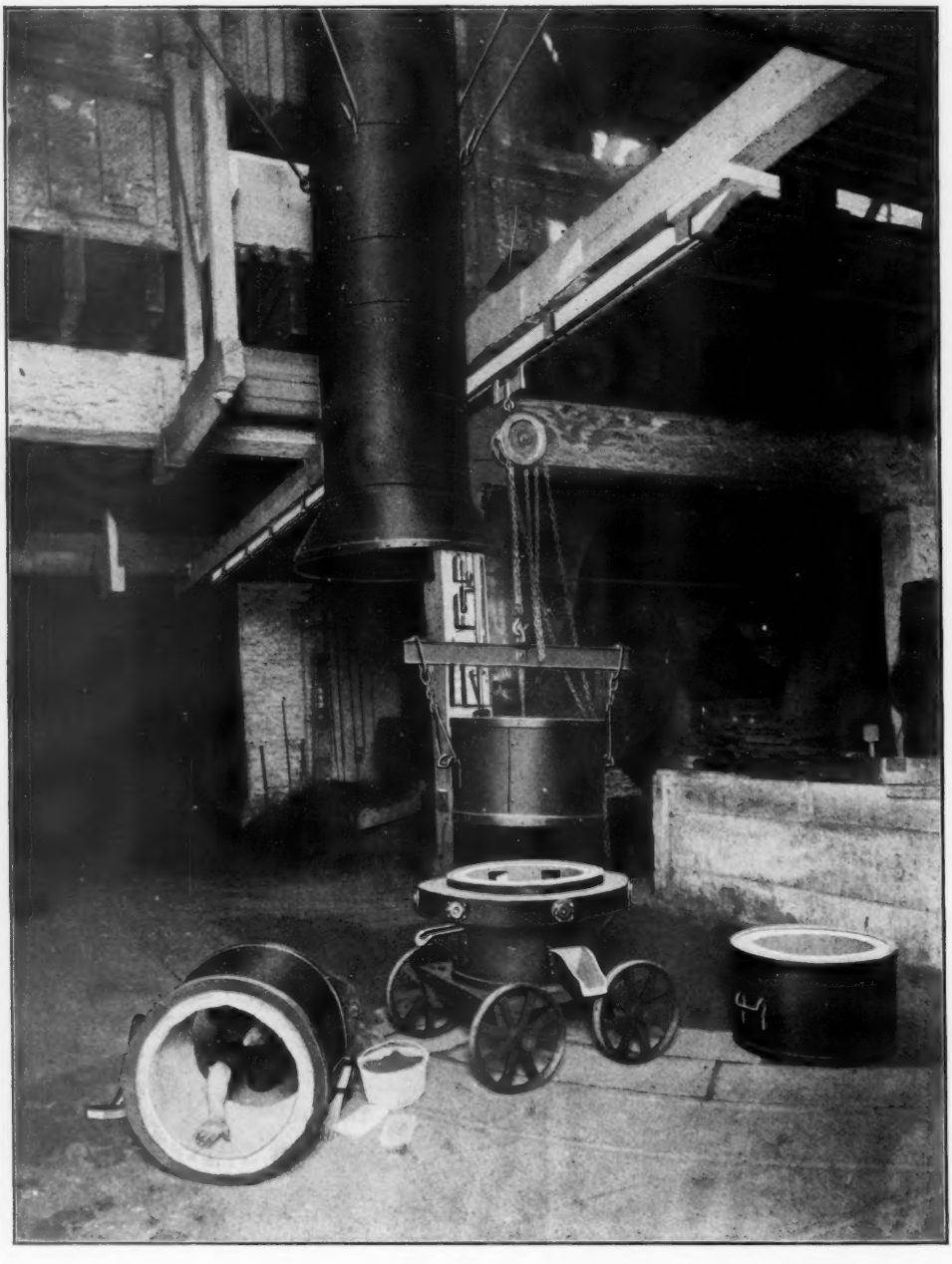


W J. KEEP'S SECTIONAL CUPOLA.

section and put the other three sections in place, daubing the joints on the inside.

Roll the cupola under the stack and connect the pipe between the blower and the wind box. Make a charging platform out of boxes or flasks and charge 100 lb. of coke and light the fire two hours before you wish iron. When this coke is well lighted charge 60 lb. of coke and 200 lb. of iron, then 30 lb. of coke and 200 lb. of iron, and so on. The cupola holds four charges, which can be put in in 15 minutes.

Break the pig iron into pieces about 10 inches long and the scrap as small and charge evenly. If you wish to hurry the fire in lighting, you can connect the wind



W. J. KEEPS SECTIONAL CUPOLA.

pipe from the blower to the slag hole before it is connected to the wind box.

Put the blast on at the tuyeres 15 minutes before you want iron.

The cupola will melt 2,000 lb. of iron per hour and 18 charges, or 3,600 lb. can be melted at one heat. Two or three heats may be made the same day. Begin to slag after the eighth charge. The iron will be as good or better than if melted in a large cupola.

The blast can be delivered from a No. 2 Sturtevant fan driven by a five horse-power motor. It takes four and one-half

horse-power to drive the fan at 1,500 revolutions per minute. The following are some of the advantages:

A test charge of 100 lb. of iron will show the quality of any pig iron or mixture if the fire has burned two hours, that is, if the cupola is as hot as a large cupola.

On days when from any cause the large cupolas are not run, the foreman and his assistants mold and take off two or three heats and earn part if not the whole of their wages, and at the same time, make work that is needed.

During any shut-down repair castings can be made for quick "while you wait" repairs. The iron may be ready to pour by the time a piece is molded.

If an important piece is lost at the regular heat it can be made the same night or early next morning.

For special mixtures, such as white iron, chilling iron, semi-steel or soft iron for patterns, the results will always be as calculated.

If molders break a heat, the cupola can be rolled in place and started before the men get out of the shop, and work that is needed can be made, so as to keep the rest of the shop running. As a result, very few heats are broken.

In case of a strike, enough castings can be made by the foreman and a few others to use the castings on hand.

Patents have been applied for on this cupola, and it is manufactured by the Northern Engineering Works of Detroit, Mich.

PRACTICAL ALLOYING. II.

Alloys: Their History and Peculiarities.

BY JOHN F. BUCHANAN.

The story of the alloys forms an important chapter in the history of our planet. They are closely identified with the struggles of mankind to gain the mastery in empire, and in the arts and industries. It is worthy of note, that the supremacy of the nations, in successive epochs, has depended as much upon engineering, or the skill of the metal workers, as upon what is called the "force of arms." Even in our own times the superior mechanism of a modern rifle has altered the political arrangement of the map; and in times of peace the most favored nation has generally been the most up to date, industrially. The ascendant nations have ever been in the van of scientific enlightenment and achievement. Warfare, which was once a matter of big battalions, is now a question of mobility and big batteries. Engines of war have always had some influence in adjusting the positions of the powers, and in many of the revolutionary periods, armaments have been accounted more than troops. All of which shows that a knowledge of mechanics and the control of metals are of some importance in deciding the destinies of the nations. Alloys have undoubtedly played a prominent part in the advancement of civilization. Historically, they are coeval with the creation—the mention of brass in Genesis leads to this inference. If we are to credit the early records, brass was first made in the bowels of the earth. It was a prehistoric discovery of nature. That brass was known to the ancients is beyond dispute. Mines containing ores from which this yellow metal was produced, were held in high esteem, but it is doubtful if the early metalworkers had any definite knowledge enabling them to control the product. It is no uncommon thing for the natural excellencies of a mine, or its ores to create a world-wide reputation for the metals they yield. "Veille Montagne" Zinc, "Lowmoor" iron, and "Lake" copper are modern examples of such fame. But not to lose sight of the historical view of our alloys, we must stretch back to mark the transition from the neolithic or new Stone Age, to the Bronze Age. What we term the Bronze Age, started early and continued late in the world's history—even unto this day bronze shares the honors with steel and iron in constructive and ornamental metalwork. Brass and bronze are often confounded by people who ought to know better. They are two distinct alloys—the former being composed of copper and zinc, and the latter being a mixture of copper and tin—and there are decided contrasts in their characteristic properties.

The word bronze is of comparatively modern origin, being similar to the Italian *bronzo*, which is in all probability derived from *bruno*, signifying the brown color of the metal. While some of the ancient bronzes compare favorably with the later products of the metal industry, they invariably contain traces (sometimes even considerable percentages) of lead, nickel, silver, iron, and gold. It is inferred from many examples of these early bronzes, that the ancients had not acquired the modern

art of separating the individual metals—copper and tin from the ores. The early smelters produced the bronzes by a judicious mixture of the ores and were probably unaware of the impurities locked up in them. Ores are occasionally alloys, or combinations of the metals, and doubtless the earliest alloys used were reduced direct from the ores by the simple application of heat. The systematic study of the alloys was not begun until the latter half of the eighteenth century, but methods of tinning and gilding metals and the use of amalgams were known to the Romans. Bronze casting was also an important industry with them. Statues were erected in such numbers that they finally became a by-word.

According to Pliny, four varieties of Corinthian copper were made, all four being alloys of gold, silver and copper. The white variety contained an excess of silver, the red had an excess of gold. Number three was a mixture of the three metals in equal proportions, and the fourth variety, hepatizon, derived its name from its having a liver color. It is a remarkable fact that metals seldom attain to their fullest usefulness in a state of purity. However desirable pure metals may be for some manufactures, as dyes, drugs, or alloys of the precious metals, it is generally recognized that but little can be done with a metal until it has been combined with some other element. It would seem to be a law in nature that none of the elements reach to their greatest usefulness until they have been united with some other substance by mutual affinity. Water (H_2O), Air ($O_5^1 + N_5^4$), Salt (NaCl), and many other substances which minister to the support of life may be cited as compounds typical of the chemical energy which permeates the natural world. Nowhere is this power of attraction and chemical union more evident than in the mineral kingdom. The earth is full of compound substances; and with all the accumulated science and technical insight of modern philosophy, the last word has not been said on the condition and constitution of matter. And there are marvels in metals, just as truly as there are wonders in chemistry. In the sixteenth century the "Gnomes" of Paracelsus,—sprites said to preside over the inner parts of the earth and to reveal its treasures,—were invented as a foil to the inquisitive. Later, the "phlogiston" of the Alchemists furnished a convenient reason for chemical changes in the metals. In the analyses of time many such visionary, extravagant theories have been dissolved, but so far as alloys are concerned, there still remains a bewildering host of problems which cannot be explained by any available scientific rules. We have to acknowledge the existence of several allotropic conditions of metals and alloys which defy explanation. An alloy of platinum and iridium shows the remarkable property of being attacked by acids to which the pure metals are entirely indifferent.

It has not yet been demonstrated how the famous Mitis castings revert from the fibrous condition, back to their original strength and structure; or how two soft metals like tin and copper unite to form a flinty compound like bell metal or speculum; or how two malleable metals like gold and lead lose that property, immediately a trace of the alloy is introduced; or how two stable metals like nickel and aluminum, in certain admixtures, crumble into powder a few hours after they have been combined; or how aluminum should exert such a powerful influence on the color of gold as to produce the remarkable white colored alloy (gold 90, aluminum 10) discovered by the late Prof. Roberts Austen. Many other phenomena bearing on the relations of the metals entering into combination as alloys, could be instanced. From recent experiments M. Guillimane has shown that a Ferro-nickel alloy, containing 25 percent nickel, is almost as insensible to the action of a magnet as copper, notwithstanding the fact that iron and nickel are two of the substances most readily attracted by a magnet. A still more singular property appears in the discovery that the magnetic properties of the constituents may be conferred on the alloy by subjecting it to great and rapid cooling. Thus, we have an alloy, which, at ordinary temperatures is non-magnetic, but which becomes magnetic when cooled further. Advantage has been taken of this unique property of ferro-nickel alloys in the construction of some new scientific instruments and electrical appliances. But we must not make too much of the novelties presented by some alloys; the practical points of alloying are of more importance than the enumeration of metallic curiosities. The ordinary definition of an alloy teaches that it is a compound of metals obtained by fusion. The alchemical usage of the verb *alloy,* meant, to temper one metal with another, the alloy always being the inferior metal, as copper in gold, or silver. This rendering still clings to

us. Sterling silver is an alloy of 925 parts, by weight, of silver, combined with 75 parts of copper. In the language of the assaying office, the copper in this example is termed the *alloy;* but in a technical sense the metal resulting from the combination of these proportions of silver and copper, in a liquid condition, is the alloy proper. Again, in brass foundry practice, the metals which are added to the molten copper to make an alloy—as lead and zinc in cock metal, or tin and zinc in gun metal mixtures, are termed the "composition"; but an analyst would state the composition by the percentage of *all* the constituents contained in the alloy. Jewelers sometimes employ zinc in gold alloys; it is generally used in the form of brass and is known by them as *composition.* Other examples of the misuse of the word alloy, are the well known trade terms, "hardening," "temper," etc. It is evident we begin to need a new definition of an alloy. The final product derived from the mutual solubility, or the fusion of two or more metals, is generally regarded as a perfect alloy. But some years ago the union of a metal with a non-metal was not recognized in that way. Cast iron has only recently been brought under this category, and many of the modern alloys now manufactured as commercial specialties, as "Meteorite" (= Al + P), silicon-copper, etc., do not come under the old description of perfect alloys. It has also been customary to regard all mixtures containing mercury as amalgams; but there are at least two alloys with a fair content of mercury, which cannot be so classed, viz.: Dronier's malleable bronze, and Kingston's anti-friction metal. So that it would seem wiser to allow that the union of a metal with any other elements should be treated as an alloy, *so long as the solidified mixture retains the essential characteristics of a metal.* From a technical standpoint the commercial value of the metals entering into an alloy should not be taken into account at all. The "fineness" of gold is a relative term which might be as well expressed by "hardness," or any other quality. The importance of an alloy is not regulated by the price of its components as some erroneously imagine. The things that matter are its chemical and physical properties and its suitability for the duty laid upon it. The presence of metalloids has a very decided influence on the structure, strength and solidity of metals and alloys. Sometimes it is a good influence; but not infrequently it is for evil. The worker in alloys is therefore compelled to be more careful in his manipulations than the worker in metals which are not alloys. Besides being more difficult to tool and less fit for wear and tear, unalloyed metals are, as a rule, not so well adapted for castings. Copper, nickel, and aluminum are very tenacious metals in the form of rolled sheets, rods, or tubes; but if the same metals are reduced to the molten condition and poured into molds, the castings are generally disappointing, both in respect of solidity and tenacity. Heated to fusion, these metals absorb oxygen, and in cooling down to the solid condition they retain more or less of the dissolved gas, which pro duces a honeycombed structure.

To overcome this defect, and to enable the founder to procure homogeneous castings with these metals, Messrs. Cowles have advocated the addition of a small percentage of silicon in the case of copper; Dr. Flietman advised the use of magnesium with nickel; and in the case of aluminum, Dr. Richards has recommended an addition of zinc or copper. Comparatively few castings are made from unmixed metals nowadays. The principles of alloying are found to be so convenient and so advantageous, that with the exception of electrical appliances, better results may be achieved, and better mechanical properties may be imparted to the castings, if the mutual solubility of metals is regarded in the preparation of the metal to be cast. The art of alloying metals involves many principles requiring much care and intelligence to attain the qualities desired in the finished product. Alloying has reference to the chemical relations of the metals and the methods of preparing and combining them; but, with the exception of some few dual alloys, as alloys of copper-tin, copper-zinc, lead-tin, silver-copper, aluminum-copper, etc., our knowledge of the effects of combining metals is far from being complete. Systematic researches have been confined chiefly to the copper alloys. This is due to the wide range of properties copper is able to impart to, or receive from, other metals. The changes effected by alloying metals are generally more marked if there is considerable difference in the characteristics of the metals used. The alloying of metals has generally a tendency to promote fusibility, fluidity and hardness; and for the purposes of castings, the homogeneity of a metal is nearly always improved by the addition of some other element. Color is also

an important feature in alloys, but the coloring power of metals is more variable in alloys than in some other compounds employed for dyes and pigments. Ledebur arranges the useful metals in the following order: Tin, nickel, aluminum, manganese, iron, copper, zinc, lead platinum, silver, gold. He says: "Each metal in this series has a greater decolorizing action than the metal following it. Thus the colors of the last members are concealed by comparatively small amounts of the first members." The alloy used for nickel coinage affords a good example. This alloy is composed of copper 75 parts and nickel 25 parts; the comparatively small quantity of nickel is, however, sufficient to completely hide the red color of the copper. But the color study of alloys has been pushed into the background by the more pressing need for purely mechanical effects, and variations in the physical properties of the metals are of first importance to engineers.

The nature of alloys has always been a matter of considerable controversy. Some of the metals combine in certain definite equivalents, termed atomic proportions, to form chemical compounds. Alloys of this description seem to possess superior qualities, and to be more stable than those produced by the haphazard admixture of metals in a liquid condition. Several metals may be dissolved in one another in all proportions, to form homogeneous alloys, while others refuse to be combined in any proportions which would qualify them to be classed amongst the useful alloys. When a mere mechanical mixture of metals is formed in an alloy, disinct crystals occur with one metal, between which the other is visible. Whereas when an alloy is formed by the chemical combination of the metals, no such irregularities appear, and in some cases, the original equivalents cannot be destroyed by remelting. So that when two metals unite to form a chemical compound, we have a new subsance with properties entirely different from the properties of either of the elements which formed it, and because of the affinity or chemical attraction of the elements, it requires some superior power to separate the particles of this new combination. It would be interesting to know if those metals which adhere well in electroplating processes are, in any special sense, fitted to form true alloys. Electroplaters are aware that nickel adheres well to platinum, tin adheres well to copper, zinc adheres well to iron, gold adheres well to silver, mercury adheres well to tin. Is this due to chemical affinity, or does electricity contribute to the reciprocity?

Again, some metals combine very readily with certain metalloids, as iron with carbon; copper with silicon; nickel with arsenic; aluminum with phosphorus; lead with oxygen, etc.; but by the introduction of a third element the chemical relationship of these combinations is disturbed. The inference to be drawn is that the union of a metal with a metalloid, even when they form a chemical compound, is more sensitive than a chemical compound of two metals. As a rule, a small addition of a third element in a simple alloy of two metals, helps to form a bond of union between them. For example, copper and iron combine with difficulty, but copper, zinc and iron produce many homogeneous alloys of great tenacity. Again, nickel and aluminum make an unstable combination, but nickel, copper and aluminum give a series of remarkably tough and permanent alloys. Mercury and iron have no affinity for each other, but if tin is intermixed with these metals an amalgam may readily be formed.

The behavior of an alloy cannot be deduced from the behavior of the components, neither does the apparent solution of one metal in another give any guarantee of homogeneous metal. It sometimes happens that certain proportions of the constituents in an alloy combine chemically, while others exist in a state of mixture or solution. The solidified mixture in such examples presents a mixed appearance in the fracture; this is due to the different densities, fusibilities or chemical properties of the alloying metals. Wherever there is a tendency to this condition, it may generally be aggravated by the slow cooling of the metal, or by raising the temperature of the molten alloy in excess of the heat required to render it fluid enough for castings. The character of many alloys is greatly modified by remelting. Alloys containing tin or aluminum generally show an increase of these metals after frequent fusions; bells cast from metal which has been repeatedly remelted, acquire a disagreeable tone because of the formation and solution of oxides in the molten alloy; and alloys containing volatile metals, as zinc, arsenic, antimony, etc., may be rendered practically worthless by prolonged melting. The presence of impurities in the metals used for making alloys is also a source of trouble; very small quantities of some ele-

ments seem to have far reaching effects on the properties of alloys.

Naturally, the characteristics of dual alloys are easier maintained than combinations of three or more metals. Some of the most important alloys in the industrial arts, are unsophisticated combinations of two metals. Brass (Cu + Zn), bronze (Cu + Sn), nickel-silver (Cu + Ni), aluminum-bronze (Cu + Al), plumbers' solder (Pb + Sn) and standard gold (Au + Cu), and silver (Ag + Cu), are all dual alloys. Various additions have been made to these alloys with a view to improving their mechanical properties, modifying their appearance, or reducing their cost, but the essential qualities of the alloy, in each case, can only be brought out by suitable proportions of the two metals indicated, being incorporated in the manufacture. Complex alloys are on the increase; and subtle combinations are being devised to meet the wants of engineering and architecture. The alloys of the future will therefore acquire closer adherence to chemical principles, a better knowledge of the behavior of *liquid* metals, and some more scientific method of reduction than the open or reverberatory furnace. Delicate combinations demand delicate handling. This applies to alloys in particular, as they nearly always contain elements with weak affinities and are prone to oxidize, volatilize and deteriorate in the heat.

CAR WHEEL MANUFACTURE.

A method of manufacturing castings (as it is designated by the patent papers) has been devised by Jacob K. Griffith of Latrobe, Pa. Fig. 1 shows in vertical section a mold with its contained casting, illustrating the application of the invention in the casting of one form of car wheels. Fig. 2 is a similar view on a larger scale with lines indicating in diagram the progressve chilling of the mteal. The inventor avers as follows: "In the manufacture of cast-steel car wheels, wheel blanks from which car wheels can be rolled, and like cast-steel articles having a hub and rim and an intermediate diaphram thinner than the hub and rim, great trouble has been experienced by reason of the shrinkage cavities which heretofore have formed in the metal generally a short distance within the periphery of the wheel, so that as the wheel wears down the shrinkage cavities are eventually exposed and the wheel then rendered useless. The presence of such cavities is also an element of danger, because they form lines of weakness on which the wheels are liable to break. Casting with sink heads has been employed to prevent these difficulties as far as possible; but such mode of casting is unsatisfactory and is a source of expense and difficulty. I have discovered a means of making such steel castings with little or no shrinkage cavities or with shrinkage cavities so displaced in position as to be harmless without need of employing sink heads or like devices. This renders it possible to make car wheels with much less expense than has been possible heretofore and to secure a better product."

Just how Mr. Griffith proceeds about this work is outlined in the engravings. The runner has at A a head box through which

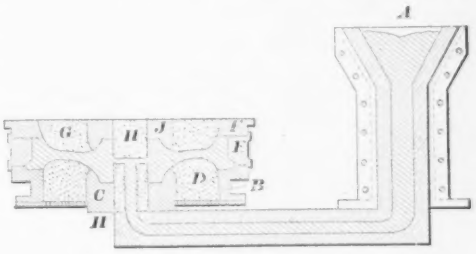


Fig. 1

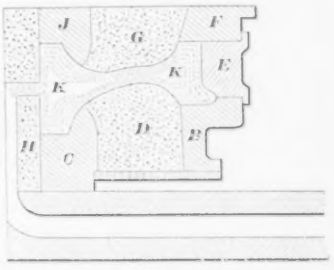


Fig. 2

the molten metal is supplied to the casting. The drag has an outer chill B which comes in contact with the bottom face of the casting at its periphery. A central chill C is in contact with the outside of the hub of the wheel and D is the sand against the intermediate or web portion of the wheel. The cheek piece at E also is a chill for the periphery of the wheel. The cope has an outer chill at F, an inner chill J for the top of the hub and a non-conducting material, such as sand, for the top of the web. At H is the center core or hub core. Instead of casting the wheel by bottom casting from a central runner, as illustrated in the drawings, which permits the molder to cast several molds at the one operation, he may

cast from the top by pouring from a head box, etc. The gate at which the metal enters the wheel cavity will be placed near the center of the hub but where the core is of small diameter the gate can be formed at the end of the hub. Mr. Griffith fills his mold as quickly as possible and in casting a 33-in. car wheel claims he fills the mold in about thirty seconds. The mold thus filled chills substantially as depicted by the dotted lines in Fig. 2. The inventor finds that the steel in contact with the chills solidifies at the rate of about 3/8 in. per minute but in contact with the sand it cools much more slowly.

The chills at the ends and periphery of the rim of the wheel and at the ends of the hub cause these to solidify very quickly. The web and the inner sides of the hub being in contact with the sand cool slowly and when the wheel has set to the innermost dotted line in Fig. 2 there are still liquid portions K extending into the web and the shrinkage cavities will be found in these last-cooling portions. "The rapid contracting of the rim, however, acts upon these relatively small interior bodies of molten metal and subjects them to a strong compression exerted inwardly in the plane of the web, so that at the time when the metal at the gate is solidified sufficiently to cut off the entrance of further molten metal to the casting this strong inward pressure of contraction due to the natural cooling of the metal in the rim will act on the still molten interior portions and will compress the same, so as to eliminate or greatly reduce the shrinkage cavities. The chilling and setting of the metal at the outer sides of the hub offers resistance to the inward contraction of the rim. The chills acting on the three sides of the rim chill it uniformly, whereas if the chill were applied to the end and to one of the other two sides only it would be ununiformly chilled."

The distance between the chill surfaces at the hub of the wheel is greater than the thickness of the web between the hub and rim. The interior of the hub and web remains fluid until the rim has solidified and the molten metal has free access to the web from the gate. The inventor has found in practice that when the gate is of ordinary size the metal at that gate will solidify in about five minutes, at which time the admission of fluid metal to the casting will cease; but the cooling of the casting has then so far progressed that the interior unsolidified portions are small in volume, as indicated in the drawings, and an efficient compression will take place. When the casting has sufficiently cooled to enable it to be removed (say in about ten minutes after casting a car wheel of ordinary size), he removes it from the mold. It will then have contracted in diameter about one-eighth of an inch out of a total ultimate contraction of thirteen-sixteenths of an inch in a thirty-three-inch wheel. The casting is then embedded in ashes to cause it to cool more uniformly and slowly than if it were in the open air or were allowed to remain in the mold in contact with the chills. The body of sand which adheres to some extent to the web after the wheel is removed will afford a natural device for retarding the cooling of the web in the manner desired.

PIG IRON FOR FOUNDRY WORKS.*

BY P. MUNNOCH.

Pig iron varies in character and composition according to the class of ore or mixture of ores, from which it is produced, and also according to the methods employed in smelting, as well as the character and quantity of fuel and flux used.

Pig irons produced in any one district from similar ores are usually similar in character, though from time to time considerable variation occurs in the composition of the iron from any one furnace, and mainly upon this fact depends the necessity of employing a chemist in the foundry, as otherwise, mixtures once found suitable for any particular casting, or class of castings, could always be relied upon to give the same results. However, owing to the variations occurring constantly in all pig irons, though in some respects some vary considerably more than others, the same brand or mixture of brands are found in actual practice to give very different results at one time, compared with another.

As the pig iron produced in different districts vary in composition, and therefore in character, the founder, by mixing irons from different districts, is enabled to produce compositions suitable to the various requirements of the different castings, upon the production of which he may be engaged. These mixings which are the result of careful trial and observation, are usually suitable for the purpose for which they are required, though sometimes the reverse is the case; but the variations occurring in the compositions of the different

*Read before the Cleveland (Eng.) Institute of Engineers.

irons used often produce quite a different result from that desired.

The distinctive character of any brand depends upon its composition. The grade or quality depends chiefly upon the amount of sulphur, silicon, and total carbon present, and also upon the temperature of the metal leaving the furnace, and upon the conditions of casting and cooling.

There is no sharp line of demarcation between the grades of iron produced at the blast furnace one grade gradually merging into another; therefore it will be seen that the iron delivered, will depend, to a certain extent, upon the ideas of the sampler, and no doubt the amount and grade of the iron made at the furnace, as compared with the orders on hand, to some extent influence his judgment.

Table I. gives typical analyses of pig irons from different districts. These are chiefly from the author's own analysis, one or two having been added to make the list complete. No. 3 iron is taken in each case for sake of comparison.

TABLE I.

TYPICAL ANALYSES OF PIG IRONS.

	Grade	Combined Carbon	Graphitic Carbon	Manganese	Silicon	Sulphur	Phosphorus
Cumberland Hematite	No. 3	.17	3.51	.14	2.49	.040	.035
East Coast Hematite	No. 3	47	3 32	.87	2 33	.057	.050
Cleveland	No. 3	.17	3 00	.50	2 75	.050	1.54
West Yorkshire	No. 3	.35	3.10	.95	3.00	.063	.97
Lincolnshire	No. 3	.75	2.76	1.80	2 14	.036	1.27
Derbyshire	No. 3	.35	2.97	.80	2.47	.035	1.40
Northamptonsh'e	No. 3	.08	3.04	.29	2.75	.020	1.69
Nottinghamshire	Mo 3	.15	3 20	.40	2.70	.040	1 10
Lancashire	No. 3	.18	3.25	.71	3 03	.051	.67
North Staffordshire	No. 3	.47	2.90	2.05	2.50	.035	1.25
Ayrshire	No. 3	.47	3.01	.89	2.33	.027	.56
Ayrshire	No. 3	.43	2.57	1.49	2.63	.033	1.15
Lanarkshire	No. 3	.19	3.10	1.50	3.15	.014	.81
Stirlingshire	Close No. 3	.68	2.72	1.08	1.56	.101	.61
South Staffordshire	Cold Blast	.55	2.50	.55	1.05	.101	.48
North Yorkshire	Cold Blast	.63	2.52	.48	.98	.046	.10

Variations in the Composition of Pig Iron.

In ordinary foundry pig irons the variations in the amounts of total carbon, phosphorus, manganese, and sulphur are generally small compared with the variations of silicon. This element varies to a very great extent from time to time, and a variation of 2 percent or even more may be met with in the same delivery of iron.

This is an extreme case, but a greater variation than this is possible, and may occur in any one grade of the same brand.

As a rule irons made in the same districts from similar ores are similar in composition. The different brands however, differ slightly. One may usually be high in silicon and low in total carbon, and another usually low in silicon and high in total carbon. In others there may be a difference in the amount of phosphorus, manganese or sulphur. All, however, will be found to vary to some extent from time to time, though some vary to a considerable extent more than others.

An alteration of some of the details in the method of manufacture will often produce a difference in the general composition of the iron made.

Where irons are made from mixtures of ores there is usually more variation in the manganese and phosphorus than is the case where irons are made from one class of ore.

TABLE II.

VARIATIONS IN ANALYSES OF PIG IRON.

Grade	Combined Carbon	Graphitic Carbon	Manganese	Silicon	Sulphur	Phosphorus
CLEVELAND IRON—IDEAL ANALYSES						
No. 1	.10	3.30	.65	3 50	.02	1.60
No. 2	.15	3.20	.65	3 30	.03	1.57
No. 3	.30	3.00	.60	2.75	.05	1.57
No. 4 Foundry	.40	2.85	.55	2.25	.08	1.55
No. 4 Forge	.70	2.50	.50	1.75	13	1.57
Mottled	1.30	1.77	.30	1.10	.25	1.58
White	3.05	nil.	.20	.75	.45	1.60
CLEVELAND IRONS—ACTUAL ANALYSES						
No. 1	.15	3.15	.60	2 50	.033	1.59
No. 3	nil.	3.10	.55	3.65	.040	1.39
No. 3	.80	2.60	.57	1 40	.054	1.54
No. 4 Foundry	trace	2.95	61	3 53	033	1.51
* " " "	.56	2.69	.40	2 10	.081	1.60
* " " "	.97	2.47	.39	1 21	.075	1 58
‡ " " "	from			2.24		
‡ " " "	to			3.96		
No. 4 Forge	.50	2 65	.40	2 45	095	1.61
No. 4 Forge	1.12	2 17	.27	.93	.141	1.56
Mottled	1.46	1.76	.32	1.75	280	1.59
"	.90	2.30	.31	.93	.237	1.63
HEMATITE IRONS						
No. 1			1.35	5.25		
"			.93	2.39	.027	.06
"	.96	3.77	.72	1.04	.027	.06
No. 2				1.75	.038	06
"	.92	3.14	1.38	1.23	.043	.06
No. 3	.55	3.15	.75	1.40	.080	.06
"	.45	3.33	.90	3.10	.030	.06
No. 4 Forge	.40	3.02	1.12	2.91	095	.042
"	.73	3.13	.48	.60	.116	.065

* Same delivery. ‡ Same delivery

As a general rule in any one brand of iron, as silicon increases, sulphur decreases, and as silicon goes down sulphur goes up. This rule, however, cannot be applied haphazard to any collection of pig iron samples, as a high silicon is frequently associated with a high sulphur, and a low silicon with a low sulphur.

Table II. contains an example of ideal analyses and grading of Cleveland (Eng.) iron. Also several examples of extreme variations actually found in the irons used at works of Messrs. Richardsons, Westgarth & Co., Ltd., Middlesbrough, and are inserted by kind permission of Mr. T. Westgarth, managing director.

Influence of Composition on Grade and Fracture of Pig Iron.

No. 1 iron is usually higher in total carbon and manganese, than the lower grades and also lower in sulphur. Silicon is generally, but not always high. As the grade goes down sulphur and combined carbon increase, whilst silicon and manganese generally decrease. Irons rich in total carbon have a much darker and more open grain than irons otherwise similar in analysis which contain a lower total carbon. This is due to the higher content of graphite. Irons with a low total carbon usually have close grain and a light colored fracture.

Sulphur to a large extent controls the grade as determined by fracture and also controls the combined carbon. Combined carbon usually increases with increase of sulphur. Irons low in sulphur usually have a large open grain, as it increases the grain becomes closer.

With a high total carbon sulphur may be increased slightly above the normal without affecting the grain; in this case there is usually an increase in combined carbon. Silicon in ordinary normal foundry irons appears to have only a slight effect on fracture and grade. When silicon increases it usually displaces total carbon, thereby lowering the combined carbon. Iron with above 4 percent of silicon usually shows a silvery appearance, and is called glazed iron. With a low silicon a relatively higher total carbon is necessary to give an iron of similar appearance to one which contains a higher or normal silicon.

Iron low in silicon is very sensitive to the action of chilling and this is greatly influenced by both sulphur and manganese. Manganese in ordinary foundry iron does not appear to have much effect upon appearance of fracture when below about 3 percent, although the presence of much manganese renders the iron hard to drill or machine. Practically the effect of manganese is to increase the combined carbon without affecting the grade as determined by fracture. Combined carbon does not appear to have a great effect on the appearance of pig iron except when the iron begins to show a forge or mottled fracture.

Phosphorus has practically no effect upon the grade of pig iron as determined by appearance of fracture. As phosphorus increases total carbon decreases, and the normal amount of total carbon varies from about 3.75 percent in normal hematites down to about 3.30 in normal Cleveland irons containing 1.5 percent of phosphorus, that is to say, with an increase of 1.5 percent of phosphorus there is a decrease of 0.45 percent of total carbon.

Phosphorus has no effect upon combined carbon, but as phosphorus increases the iron shows a lighter color due to the phosphide of iron present.

The appearance and grade of pig iron is affected to a great extent by the varying conditions of casting and cooling. This makes it a difficult matter to determine the effect of composition on fracture with any degree of certainty.

Mixing by Analysis.

The object of this is to turn out castings of uniform analysis.

As the physical or mechanical properties of cast iron depend on its chemical composition, together with the effects of the conditions of melting, casting and cooling, it may be taken as a general rule, that metal of similar analysis, melted, cast and cooled under similar conditions, will produce resulting castings having similar physical or mechanical properties. This leads to the foundation of mixing by analysis, that, if the resulting metal is of the same analysis and the other conditions are the same, the castings produced will have the same properties, independent altogether of the brand or brands of iron used. The chemist, therefore, given irons of suitable composition, is able to produce an iron having the composition and character of any particular brand of iron.

This in turn brings forward the fact, that the properties of such special irons as cold blast depend upon the composition; cold blast is only the means of producing this composition, and if an iron having the same composition, could be produced by means of hot blast, the iron would have the same properties.

Furnaces working with hot blast usually produce an iron having a higher total carbon when making iron which is otherwise similar in analysis.

It is possible to reduce the total carbon by the addition of steel and thus duplicate cold blast irons.

Selecting and mixing irons by analysis renders the founder independent of any particular brand or brands of iron, and enables him to substitute low priced for high priced ones.

The low priced irons may in some cases be more suitable than the higher priced irons.

In some districts, and with some classes of work, the saving to be effected is very small, and the chief benefit obtained is from the greater regularity of the composition and mechanical properties of the castings produced.

The founder who is so placed that he has irons from different districts at his disposal is enabled to change his irons as the markets change, and at the same time produce castings of suitable composition and mechanical properties.

The ideal method of working is to buy irons by analysis. At the present time this is a difficult matter, as few makers of pig iron are willing to sell by analysis. Those who are willing to do so require a higher price for selecting the iron.

At the present time therefore irons must be bought by grade and as they vary from time to time, a certain amount of stock must be kept for mixing. This is not so much a question of large stocks as a judicious selection of irons which can be used to correct any irregularities which may occur from time to time in those bought, and which may also be used for producing mixings for castings requiring special or unusual composition.

Usual Composition of Castings.

It is by no means necessary when in any particular district, to turn out castings of the same analysis as would be done in another district where the irons within reach of the founder may be different in composition. In those districts where high phosphorus irons are cheapest, phosphorus will be found to be higher in the general output of castings than is the case where irons of a lower content of phosphorus are cheaper, the same also applies to manganese.

Castings for machinery and general engineering work vary greatly in composition in different districts, but as a general rule the phosphorus averages about 1 percent. This may be due to the fact that the general average of all the pig irons produced in this country is about 1 percent phosphorus.

Manganese usually varies from .3 to 1.5 percent, but the average is about .7 percent.

Silicon may vary from 1.0 to 3.0 percent. The average is about 1.8 percent. Total carbon usually 3.2 to 3.5 percent.

Combined carbon varies to a very great extent. In some cases the total carbon is entirely in the form of graphite, in others the greater part may be combined. Combined carbon may vary to a great extent even in the same casting.

Sulphur usually varies between .03 percent and .15 percent.

In special engineering castings where great strength is required, total carbon, manganese, silicon and phosphorus are usually all low.

For castings requiring to be extremely soft and tough, hematite iron alone is used.

Iron for special castings is in some cases remelted once or twice before casting. This is only necessary when a higher grade of iron than is required is being used. Where reasonable care is taken in the weighing of all materials charged into the furnace, the results will be quite as regular without this remelting.

The effect of remelting in the cupola is equivalent to lowering the grade.

Usually silicon is decreased by .2 to .3 percent.

Sulphur usually increases to the extent of .02 to .04 percent.

About 25 percent of the manganese is lost.

Total carbon increases or decreases according to the amount present, whether below or above the normal.

With regard to mixing by analysis applied to the foundry, this cannot be a success unless the necessary requirements are observed. These are briefly, a reasonable amount of stock of the different brands and grades of iron necessary and a small stock of extremes for correcting variations.

Sufficient yard room for stocking purposes; this should preferably be near the cupola to save unnecessary handling.

Suitable means for weighing all materials charged into the furnace.

Unless these requirements are complied with it will be impossible to mix by analysis.

The question as to whether or not an analyst is of benefit to the foundry, is a delicate one for him to attempt answering, and can only be answered by those who employ one.

A CIRCULAR METAL SNAP FLASK.

BY GEO. BUCHANAN.

Having had occasion recently to make some circular snap flasks for use on molding machines, it has occurred to the writer that the method used might be of interest to others. The flask is shown in detail in Fig. 1, and the molding and necessary patterns in Figs. 2 to 4. In making the mold a pulley rim is first bedded in the floor as shown in Fig. 2. The strickle A is worked round the pulley rim so as to produce a smooth surface both inside and outside the rim. The portion of the rim projecting above the floor is equal to the required depth of the flask. Small triangular sections of lead are bent to the proper radius and laid on the joint inside of the rim, as shown at B. The four blocks C C C C are set against the outside of the rim in the positions which will be occupied by the cores for forming the fittings; in other words these blocks correspond to core prints.

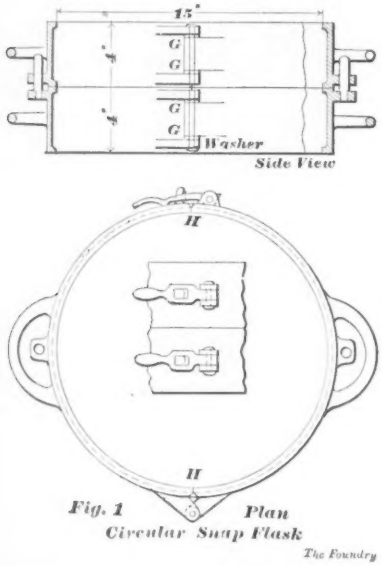
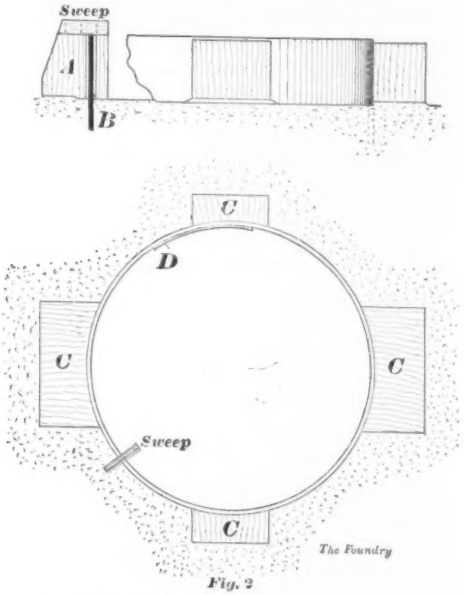


Fig. 1
Circular Snap Flask

The Foundry

The mid part (intermediate part) of the mold is then staked in position, the mold rammed up and a joint made over the top of the blocks corresponding to the core prints. The inside is also rammed up level with the top of the pulley rim and struck off. The cope or top part of the flask is next placed in position and rammed up. The cope is then lifted off and a ledge formed on the top of the inside of the rim, as shown at D, Fig. 2, a small segment being bedded in for this purpose. The segment being worked round until the rim extends round the entire circle, the pulley rim is then rapped and drawn out. The mid part is next lifted off and the surplus depth of the rim carefully filled in with sand and smoothed level with the joint. The small lead segments at B are then drawn in so as to leave an opening in the mold to form a rib on the lower edge of the flask. Of course it will be necessary to draw the wooden blocks C C at the time the pulley rim is drawn. The mid part is then replaced in position and cores introduced to fit the openings left by the core prints. The boxes for making these cores are shown in Figs. 3 and 4. The box shown in Fig. 4 is self explanatory; that shown in Fig. 3 is arranged to make either the latch or the hinge, the loose pieces being secured to the bottom of the box with pins so they can be changed for the two different classes of cores.



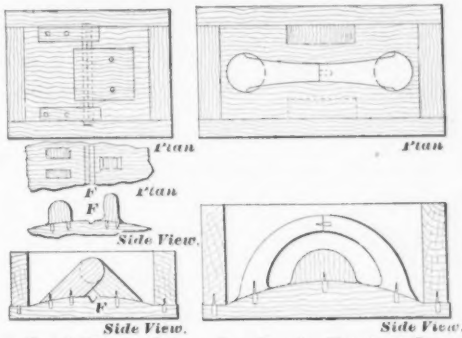
The Foundry

Fig. 2

It will be noticed that there is a groove arranged along the center of the box, as shown at F, which gives a pointed extension in the bottom of the core that cuts the metal in the mold almost in two, leaving only about ⅛ in. opposite the point. The object for this will appear later.

After the castings have been cleaned

they are placed in a lathe and both top and bottom faces are trued up. The hinge is next drilled and a steel pin introduced and riveted top and bottom, washers having been first introduced into the spaces G G in Fig. 1. The snap lugs are drilled and the catch fitted in the same way as the hinge. The guide pinholes are next bored and the flask parts made a good working fit. After all the fittings are complete a file is taken and a small nick cut opposite



Core Box for Hinge & Snap. *Core Box for Handle & Snap.*

Fig. 3 *Fig. 4* *The Foundry*

the point where the metal is only ⅛ in. thick and the flask broken along this line by a sharp blow from the hammer. The flask is now ready for use. The slightly rough edges of the break are usually an advantage as this roughness tends to keep the two parts of the flask in perfect alignment and prevent any shifting even when the hinge becomes worn.

COST KEEPING.

I notice you are devoting a great deal of space in *The Foundry* to cost keeping systems. In almost every issue there appears a new system or an additional card to be filled out by workmen or a timekeeper. These writers put me in mind of an inventor of perpetual motion who, when he finds his machine does not run perpetually, adds another wheel. They add another card, and like the inventor of perpetual motion make their systems more complicated and expensive and less likely to serve the purpose for which it is designed, namely, the production of cheaper castings. All these systems must add to the cost of castings; for the printer must be paid for cards, books must be provided in which to keep the account and bookkeepers must be paid for keeping the books.

With many of the systems outlined in *The Foundry,* the cost of these items per year is no small amount, and besides this cost a vault or safe must be provided in which to store cards and books if they are to be kept for reference, as they must be to be of value in reducing cost of castings; for it is only by comparison that we learn whether a casting is costing more or less than at some previous time.

Some years ago I went into business with a man who had been in business for 40 years, and had preserved all his books, business letters and papers for that length of time. When he built a new office and moved into it, as he did when I was in business with him, ten tons of these books and papers had to be moved, and a large vault constructed in the new office in which to store them.

With the system of cost-keeping advocated by some of the writers in *The Foundry* it would not take many years to accumulate this weight of books and cards, and in 40 years the amount would be enormous. But the question is, do these cost keeping systems pay? This question can only be answered by those who have tried them or by the results obtained as indicated by the success of firms employing them.

In visiting many foundries as I do every year, and observing their success or failure from a practical standpoint, I do not think it pays. For it appears to me that more foundries fail or go out of business who have cost keeping systems, than ones that do not, and manage their business by the rule O' thumb, as the saying is.

I might instance a number of foundries that have gone out of business with cost keeping systems, but one will probably suffice. This one was a firm with a large machine shop, pattern shop and foundry, manufacturing steam and gas engines and general castings, and I have known them to melt 50 tons of iron per day and even more for a year at a time. This firm had an elaborate system of cost keeping in every department of their plant, with an endless number of cards to be filled out by their workmen or timetakers and numerous bookkeepers to keep the account of each department and should have re-

duced cost of castings and finished product to a minimum. Yet this firm did not pay a dividend to their stockholders in more than fifteen years of existence, and at first of the present year shut up shop and will not again resume business under the same management. Last year they asked for bids from other foundries for 500 tons of castings and found that they could buy their castings at a less figure than they could make them. At least three of the foundries that put in low bids for this work that I know of have no card cost keeping systems and are successful foundries, which would go to show that card cost keeping was not a success.

Not only have many foundries expensive card cost keeping systems but they have also expensive account keeping systems. One firm with which I do business requires three separate bills for each shipment of goods, for which they furnish blanks in three colors. One of these is for the foundry account, one for the account department and one for the auditing department. These three bills each require a set of books and bookkeepers and increase cost of castings. Others require duplicate bills sent to different departments, and the bills receipted and returned to these departments when paid. This also increases bookkeeping, mail and papers to be filed away and adds to the cost of castings, while the practical foundryman requires only one bill, and when paid states on the check what it is for and requires no further receipt than the indorsement on back of check.

The tendency of some foundrymen seems to be, when they find that gold is not flowing from their cupola, as they have been lead to believe it should, is to open another cost account to increase their profits, but they should remember that the perpetual motion inventor has never yet succeeded in producing perpetual motion by adding another wheel, which only increases the power required to run the machine and the founder is not likely to reduce the cost of castings by opening another account, the keeping of which adds to their cost; and the sooner they discover this the better it will be for them and the foundry industry. Daily cost keeping systems are the invention of the younger element in the foundry business, who know nothing of the business and hope in this way to obtain sufficient practical knowledge to enable them to manage the business of a large plant from the office, without ever entering the foundry, or at least taking any active part in its inner workings.

By their system of cards and cost accounts, they hope to be able to determine the cost of every casting or line of castings, and by merely calling upon the cost keeping bookkeeper for cost of any casting, be able to make a more intelligent bid for castings than the practical man in a foundry who keeps no such account.

Now, this is all very nice if it can be done. But can it be done? I think every practical foundryman will agree with me that it is impossible to determine the exact amount of molding sand destroyed in casting any one casting, be it large or small. The exact amount of damage done to the flask and pattern, or the cost of facing, nails, and other materials required in producing the casting. The cost of these items can only be learned from cost of foundry supplies, stock taking and a system of averages of cost of supplies to pounds of castings produced in a given time; and the only thing that a man in the office can hope to learn accurately from his cards, is the cost of labor. This may be learned accurately from the cards, but is this alone of value? Let us see.

This casting which is probably a large one, for the man in the office would not care for one small one in making a bid for work, and is the first one to be made from the pattern. In molding this casting the molder may have had to wait for the pattern for the flask to be barred, cores may not fit, and time is required to file them down. He takes extra precautions in molding it and double the time is consumed in molding the piece that the same molder would require to mold the second one, more time having been required to make the cores than necessary. The labor for molding, core making, barring flasks, etc., is charged to the casting, and all these cost items are returned to the office on the cards, where they are entered upon the books as cost of casting. Should a number of castings be required from the same pattern the man in the office calls upon the bookkeeper for cost of this casting and put in a bid for the work; based upon the cost of labor required in making it. Of course the bid is too high, and the job is lost. On the other hand, the pattern may have been given to a fast molder, a flask found that required no barring, cores fit and a good cast-

ing turned out at a very low cost, and a bid put in for the work on this basis at a very low price. When the contract is secured, the pattern may be given to a poor molder and two or three castings lost before a good one is made, no allowance has been made for this, and the foundry loses money on the job. It will thus be seen that no intelligent bid can be made for work based upon a cost keeping system alone. This can only be done by taking into consideration the possibility of making the casting at a less cost than the first one, and the chances of a number of them being lost, from poor molding, bad cores, dull iron, dirty iron, etc., and these matters can only be considered by a practical foundryman, who has learned by long experience how to estimate and value these chances.

To make a success of the foundry business there must be some one responsible for results in the foundry, as well as in the office, and the most successful founders I have met are those who are foundrymen and look after matters in the foundry themselves; and men who are not practical founders but employ a thorough competent foreman, give him full power to employ or discharge every man employed in and about the foundry. Furnish him with all the foundry supplies he requires, and hold him responsible for results. This kind of responsibility ends when the card system is introduced; for I have never yet met a foreman who did not feel that this responsibility was taken from him and transferred to the main office, where the amount of work done by every man was learned from his card, and it became the duty of the man in the office to indicate who was not doing a fair day's work for his wages, and order his discharge, or such changes in the amount of work turned out as were for the best interests for the foundry.

This he cannot do intelligently from his cards alone, for a molder many have worked hard, made a good mold and a casting been lost through no fault of his. It is only by placing the blame where it belongs that justice may be done to the molder, who, of course, is the first man to be blamed when a casting he has molded is lost. His time card shows that he worked so many hours or days in molding this casting and the report from the cleaning room shows the casting was bad. This is all the data the man in the office has from which to decide who was responsible for loss of castings. No practical foundryman would deem this sufficient data upon which to determine who was responsible for the loss of a casting. For he knows that the pattern may not have been right, cores cut through, or given too much thickness, etc., and so the pattern maker may be to blame. The casting may have been lost from uneven shrinkage, and the draftsman to blame. It may have been lost from poorly made cores and the coremaker to blame. And it may have been lost from a poor rig for molding it, dirty iron, poor facing, and a variety of causes for which the firm is to blame. The responsibility for the loss of this casting can only be placed by a practical man who understands these things, and knows all the conditions under which the casting was made.

In my opinion the card system alone is perfectly useless for placing the responsibility for the loss of castings or reducing cost, and the young man who is trying to learn the foundry business will find it more profitable to place the responsibility upon his foreman and consult him in a respectable manner about everything pertaining to the inside management of the foundry, than he will to make a mere figurehead out of his foreman by a card system, that completely ignores the foreman and places all responsibility for the success or failure of the foundry upon himself.

DR. EDWARD KIRK.

Some Thoughts on Modern American Foundry Practice.*

BY JOHN C. BURNS.

In this paper the author briefly points out the fact that the modern American practice varies radically from the old school practice, and that the foundryman, like the journeyman, is surely becoming a specialist, although he is no less a mechanic, and he predicts that the foundries of the future will be operated as specialty shops to a greater extent than at present. He then goes on to point out how, for heavy work proper hoisting and handling facilities must be afforded. Power machinery is cheaper than labor. Electricity is playing an important part in the foundry, both for power and lighting. He also points out the fact that if the modern foundry foreman is to be in the van in this march of progress he must not only use modern appliances, but mix his iron by analysis.

*Review of paper read at A. F. A. convention, 1905.

METALS IN FOUNDRY PRACTICE

Devoted to inquiries from Practical Foundrymen on subjects relating to the Melting and Using of Cast Iron, Steel, Brass and Bronze.

The following experts answer questions in this department:

W. J. Keep, Cast Iron.

J. B. Nau, Metallurgy of Steel and Steel Castings.

Dr. Richard Moldenke, Malleable Castings.

C. Vickers, Brass Castings.

We have also made arrangements with several others to act as special contributors upon Brass, Bronze and other subjects. All inquiries should be addressed to the Editor of THE FOUNDRY, and they will then be forwarded to those in charge of the different subjects.

CAST IRON NOTES.

BY W. J. KEEP.

Dirty Iron.

Question: I have just been foreman about six months for this firm and have had some trouble with our iron. It is very dirty and causes castings to be rough. Can you tell me of anything else but oyster shells or limestone?

Answer: The term dirty iron describes the molder's trouble, but the iron may not contain dirt. You had better change the proportions of the iron in your mixture until you prevent the trouble. Melt your iron hot and then give it time to cool and skim off the graphite that comes to the surface. If the character of your castings will allow you to do so decrease the silicon in your mixture until there is less to skim off.

The trouble comes from some one of your irons being rich in carbon, which is a good thing generally. By a little experimenting you will soon find a mixture that will give you no more trouble. Oyster shells and limestone are the best flux and will help you.

Relation Between Shrinkage and Silicon.

Question: We find that the shrinkage of our machinery castings is .160 by the taper scale. We would like to know what point on the scale designates the unit percentage of silicon in the iron. That is, does the mark 100 on the scale designate 1 percent of silica?

Answer: The scale is graduated to thousandths of an inch. The test bar is one foot long, therefore your reading shows a shrinkage of 160 thousandths of an inch per foot for the half-inch test bar. I think that your castings would have as close a grain and would be softer if your shrinkage was .150. If a trial shows this to be so then .150 would be your standard.

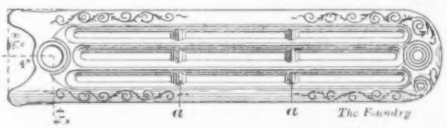
If the reading was .160 you need more silicon to reduce the shrinkage to the standard. If the reading is less than .150 you must reduce the silicon to raise the shrinkage to the standard. As the percentage of silicon increases the shrinkage decreases.

The shrinkage reading tells you whether to increase or to decrease silicon so as to keep the grade of your castings uniform.

You cannot depend upon an exact percentage of silicon to produce a definite hardness, or shrinkage, because a variation in sulphur or carbon would vary the grade and would require a different percentage of silicon to produce the standard grade, but the same shrinkage means substantially the same grade and you can keep the shrinkage uniform by varying the silicon.

Shrinkage in a Radiator Casting.

Question: We are taking the liberty of referring a subject to you which seems to have beaten us. Two chemists have advised us that it is not the iron or the coke but some local trouble probably in our molds or in our men. In each of our radiators at the point marked *a*, and only there, occurs a little defect which looks like a spongy spot or a shrink in the casting. The defect is always on the under side of the hollow cross bar. We use an ordinary lake sand oil core, well vented so



that there can be no wash. Our molds are good and clean and are faced with soapstone. No change of materials has stopped the trouble. We would like your expert opinion in the matter. We are sending you samples of the casting.

Answer: The defect is a shrink crack and is not due to any of your materials.

I should say that the patterns were defective. The samples sent show that all

corners are absolutely sharp. If you will round all corners on the outside of the cross piece and then cut out the core box so as to leave the metal of a uniform thickness the trouble will disappear. I notice, however, that in every case your core has raised so that the upper wall of the radiator (as it lays in the mold) is ⅛-in. or less thick, while the lower wall is nearer ¼-in. thick. You should pack the sand harder over the heads of the chaplets to hold the core in place. The upper surface of the crosspiece has set before it has time to shrink. The lower part of the casting is held by the already solid upper part and the metal pulls apart at the corner, which is the weakest part. A small iron chill bedded in the mold at the point where the crack occurs might chill the metal before it could shrink. The best way is to make all corners round and make all parts of the same thickness.

MALLEABLE CAST IRON NOTES.

BY DR. RICHARD MOLDENKE.

Efficiency of the Air Furnace for Malleable Cast Iron.

I. P. S. write that they wish to know whether the efficiency of the air furnace can be increased, or whether greater economy must be sought in the open hearth furnace.

While it is true that the efficiency of the air furnace for malleable is not great, being very probably less than 10 percent as given by Sir Lothian Bell and others, yet this is much a question of furnace construction and the method of working. A well constructed air furnace should melt four pounds of iron with one pound of coal. The cupola will do it eight to one, and the open hearth six to one. These are general figures. In actual practice I have often seen the air furnace do no better than two to one, and so far as cupola malleable practice is concerned, four to one is considered good, as the class of metal made by this process is very light and must be extremely hot.

If your air furnace does worse than four to one, it is time to change the lines, or study the blast arrangement to get better melting efficiency. The trouble with the air furnace malleable process is that the flame must be as non-oxidizing as possible, so that the metal is not unduly burned. Effecting a better combustion would quickly increase the melting efficiency, but would result in poorer iron, as contrary to the accepted theory the malleable melting process should not be one of refining, but simply melting with the greatest care to prevent oxidation. The lowering of the total carbon brought about by the old refining tactics, is much better accomplished by the direct addition of steel scrap.

So far as is generally known the various patented methods of pre-heating the air in the coal fired air furnace, are only so much trouble added. It is hard enough to keep the checker system of the open hearth in order, where gas must be used, and in the air furnace any successful use of waste gases to pre-heat the blast would have to be built on the blast furnace stove system to be of any value after being used for some time. When the expense of this is considered, the open hearth is certainly the desirable furnace to use.

Comparing the air furnace with the open hearth, there is this much to be said. Where heavy tonnage is the order of the day, and this is kept up pretty continuously, the open hearth is the only furnace to use. In our own interests we are taking out malleable and acid steel heats alternately, a thing which could not be done with the air furnace at all. Where, however, the tonnage is light, and is moreover apt to be intermittent, the use of the open hearth is a mistake, in spite of its greater efficiency and better results delivered. It costs too much to keep in heat for long waits, and is generally expensive to maintain. Only where the total cost a month is divided over a good big tonnage will the open hearth furnace be found unapproachable when compared with the air furnace.

As I. P. S. wish to know whether the air furnace can be successfully improved upon for malleable purposes, I can only say that the requirements of the process do not allow the improvements which can be made and are in use in the air furnace used for making heavy gray iron castings, rolls, etc. We are forced to keep the furnace small, with but little head room for combustion purposes, and must drive a heavy reducing flame over the iron, getting it up to heat as quickly as possible, so that it can be tapped out. Under such circumstances there is no show for improvement over the best in use to-day, and it were better to look into the lines of successful air furnaces in use to-day, as built by reputable firms, before experimenting to bring up the efficiency of the particular furnace in local use.

STEEL CASTING NOTES.

BY J. B. NAU.

Crucible Steel Mixture.

Question: Can you give me a good mixture for crucible steel for jobbing work?

A SUBSCRIBER.

Answer: In the crucible process the steel is obtained by melting together a mixture of different grades of irons that naturally would yield the amount of carbon desired in the steel. If this mixture is melted in a graphite crucible the probabilities are that on the first melt a little more carbon is obtained in the steel than is contained in the mixture; the second melt in the crucible will bring the carbon nearer and the third still nearer.

In a clay crucible, which in its composition contains less carbonaceous matter than the graphite crucible, less carbon will be absorbed by the melting metal than in the graphite crucible.

Thus melting a mixture of 50 lb. of iron with the endeavor to obtain a steel with 0.6 percent of carbon, the desired result will be obtained with about the following mixture: 30 lb. of steel containing .9 percent carbon; 20 lb. of iron containing .1 percent carbon.

J. B. NAU.

BRASS FOUNDRY NOTES.

BY C. VICKERS.

Cores for Brass Castings.

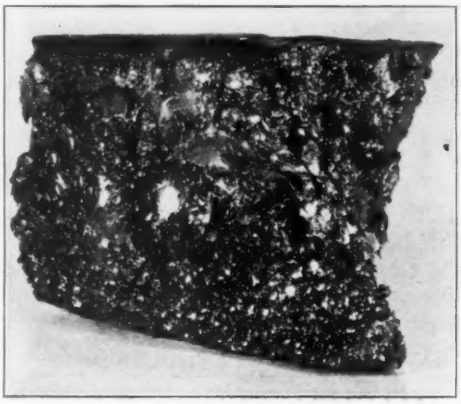
Inquiry: Can you please give a mixture of sand and binder for cores for small brass castings which would not require venting?

Answer: Glue is a good binder for such cores.

Prolonged Annealing of Cast Iron in the Absence of Free Oxygen.

The accompanying photograph shows a piece of charcoal iron which was taken from the vicinity of one of the old charcoal furnaces near Oil City, Pa. This metal was probably reduced between 1866 and 1868. It may be noted that the crystals in this iron are abnormally large. This is brought about by prolonged annealing in the absence of free oxygen, for, had it been exposed to oxygen under the same heat conditions, it would have been entirely converted to the oxide.

The analysis of it is, Si 1.94 percent, S .01 percent, Mn .15 percent, P .127 percent, TC by combustion 3.85 percent, CC by color, about .05 percent. This iron would no doubt have shown about the same analysis in its younger days. From it one would conclude that nothing has left the iron, and, as the interstices between the crystals have enlarged, the specimen has no doubt enlarged. This might be an interesting feature to some of our brother engineers in isolated sections, to bring the worn parts of their machines back to original size.



PROLONGED ANNEALING OF CAST IRON.

The same fracture is often presented in blast furnace salamanda and in chill pig beds that have been in use for some time.

J. G. BLUNT.

CASTING GEAR BLANKS.

Question: What is the proper way to cast the gear blanks shown in the accompanying drawing, so as to get good casting.

Answer: I would advise casting gear No. 1 with the plain side in the cope. Place this side of the pattern on follow board and surround it with the drag. Put the chills in and cover with facing that is about 1-15 coal dust, the rest being floor and new sand mixed in proportions that will give a good bond. Put in the six connecting gates, ram up, vent, put on bottom board and roll over as you would a green sand mold. Put the cope on and ram up with sand similar to that used in the drag. Put four risers over the cam bead and let them be 3 x 4 in. at the junction with the casting, being somewhat larger at the top.

After the mold has been dressed and

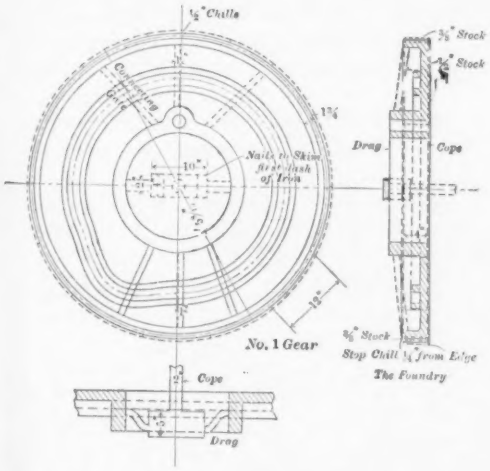
blackened with good graphite, including the six connecting gates, set the center core, which has been made in halves out of your regular core-sand mixture and with the skimming block and horn gates in the middle. Hold gas or oil flame on the mold and chills until the skin is dry and the chills are warm.

Just before dosing, wipe the chills off with carbon and linseed oil mixed, one to one.

After the runner box has been rammed up, fit a bot in the down gate, so that the box may be filled before any iron enters the gate. A piece of tin may be used, place it at the top of the down gate. The iron will melt it away.

Iron Mixture.

Seventy percent of pig which analyzes about 1.65 percent to 1.75 percent Si, .01 percent to .02 percent S, below .5 percent P and Mn, 3.50 percent to 3.60 per-



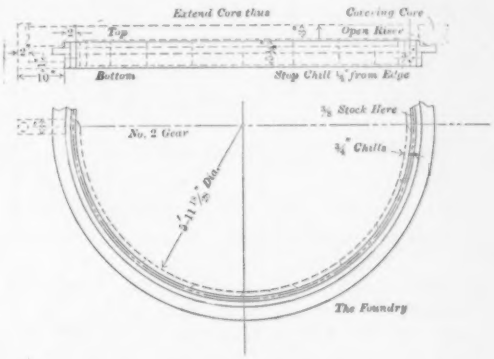
cent TC, and 30 percent scrap, the analysis of which is about the same as the pig, excepting the sulphur, that being about .085 percent.

Method of Charging Cupola.

Let the coke bed extend 24 in. above the top of the upper tuyeres. The weight of the first charge of iron should be six times that of the coke above the tuyeres. The succeeding charges should be 7½ lb. of metal to one of coke. Let the blast pressure be about 9 ounces twenty minutes after the blower is started. I assume that your charging door is 16 ft. above the tuyeres. Pour the iron HOT, keeping the runner FULL while pouring. But do not pour until it stops boiling. Only fill the risers up to a point 4 in. above the casting. Put a hand full of blackening in each one and keep the crust from forming. When the iron begins to thicken, simultaneously, add to each a hand ladle full of HOT metal, cover with sand, and weight.

Gear No. 2.

Gear No. 2 may be bedded in the floor. After the pattern and chills have been set, ram up, blacken and grease chills as for gear No. 1. In this case the pattern leaves its own core. An opening of 3 in. wide and 3 in. deep is left between the center core and the "covering core." The prime object of this riser ring being cast on is to allow three or four men to stand on the center core and keep any dirt away from



the vital part of the casting with rods or small sticks. A shield should be placed in front of the ladle to keep the heat from these men.

Gate this casting as shown by drawing and pour with the same metal that is given for gear No. 1. Owing to the fact that all irons of the same analysis do not take the same crystalline structure, when poured against a chill, I would advise you to cast small test pieces, similar in cross section to the part of the casting that would come in contact with the chill. Use the one which shows the greatest depth of closed grain with no white. I have assumed that your coke contains about .9 percent sulphur.

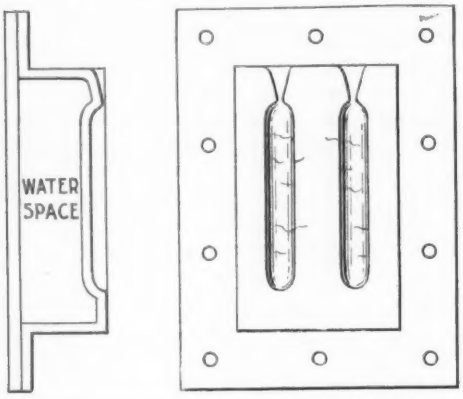
When you make the chills put some rods on the back side to hold them in place and brighten the face of the chills, except the one in front of the gate on No. 2 gear, before using.

J. G. BLUNT.

WATER COOLED CHILLS.

Question: We have some water cooled chills for making sashweights and have trouble with them cracking.

Answer: I should advise your correspondent to use the following mixture: Eighty percent pig iron whose analysis is about, Si 2.25 percent. S .01 percent, Mn below .75 percent, P below .4 percent, T C 3.60 percent, and twenty percent scrap whose silicon contents is about 1.75 percent, and sulphur about .06 percent. The remaining elements should correspond to those of the pig. The coke used should not contain more than .9 percent of sulphur. If he has better coke it would improve matters.



WATER COOLED CHILLS. METAL ¾" THICK.

Method of Charging the Cupola.

Let the coke bed extend 20 in. above the top of the upper tuyeres, and the weight of the first charge of iron be seven times that of the coke above the tuyeres. The ratio of iron to coke on the succeeding charges should be 7:1. If the charging door of his cupola is 17 ft. above the tuyeres, the blast pressure should be 10 ounces, twenty minutes after the blower is started; and, where the door is not at this height, the pressure of the blast should vary in direct proportion. The metal should be poured as *hot* as the mold will allow.

He might try putting longitudinal cooling ribs in the water jacket. This would give more radiating surface and the chill would not get as hot.

Should carbon precipitate to the top of the molten metal, he should increase the percentage of scrap or lower the silicon contents of the charge. L. G. BLUNT.

MOLDING MACHINE PRACTICE.

BY F. W. HALL.

The molding machine has been an acknowledged success for bench work for several years, and some of the leading foundrymen have installed large hand ramming machines for floor work. The amount of success met with in the latter class of machines has varied greatly. Some of the more recent machines of both types are provided with pneumatic sand ramming apparatus. This equipment enables the machine operator to produce more work per day and leaves him in a less fatigued condition when he comes to pour his work at night.

The general installment of compressed air in the foundry for various purposes has furthered the use of pneumatically operated molding machines. In connection with these machines, pneumatic hoists are used to lift the molds from the machine, to set heavy cores, etc. In some cases firms have gone to the expense of equipping the foundry with sand conveyors and sand mixing machinery, so that the molding sand for each machine is delivered to it as required. In other cases carriers or traveling floors are arranged to carry the molds to the cupola for pouring, to the place where the castings are shaken out, and to return the flasks to the molding floor.

I have often been told by foundrymen that when a molding machine is made that will feed its own sand into the flask they will be glad to install it, but in the writer's opinion they would have to wait some time for the machine, as it would naturally be so complicated that it would probably be tied up for repairs in the machine shop about half the time. In my opinion the leading molding machines of the future will be those than can ram the sand and draw the pattern with as few working parts to the machine as possible; the handling of the sand to be done by a separate mixing and conveying system. The men should work in gangs, there being some to handle the flasks, some the sand, others to set cores, close molds, and still others to do the pouring.

Very frequently foundrymen ask for a written guarantee of the number of molds a given machine will produce in a day. To

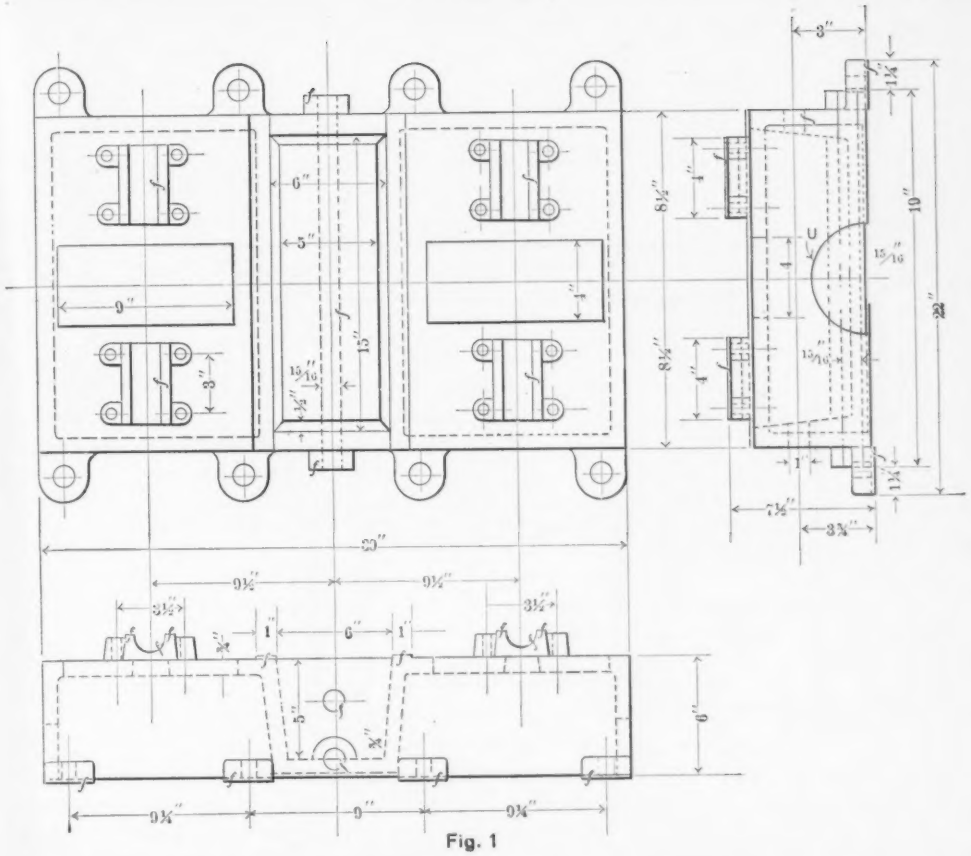


Fig. 1

be on the safe side the seller usually sets his guarantee low, as he is liable to meet opposition from the machine operators on one hand and the foundry foremen on the other. I have two instances in mind. In one a machine was installed against the foreman's wishes. He had no use for it, and as a consequence it is simply standing rusting. In the other case the foreman decided to see what could be done with the machine. He organized a gang of laborers to operate it and when it was first installed he had some difficulty in reaching the desired output. This was finally overcome and the seller went away with a check in his pocket. The firm then turned the management of the machine over to the foundry foreman. Being a good manager of men he soon had all interested in the machine and arrangements made for operating it systematically. Two men shoveled the sand into the flasks, one man operated the machine, two men set cores and closed molds; and by this system he was able to increase the output 25 percent above the guarantee, while all the men on the machine were making from $2.00 to $2.50 per day.

The foundry in question was cramped for room, and hence it was necessary to get the greatest possible output from the existing epuipment. The foreman therefore went to his gang and offered them five cents more per mold for every additional mold over the regular number. He had a dozen more flasks made and soon the men were filling these easily; another dozen flasks were added, and by adding another man to the gang these too were filled. In this manner he was able to increase the output 75 percent over the guarantee. I attribute this man's success to his skillful handling of his men, all of whom are in sympathy with him.

The casting, the mounting of which on the machine I am to describe, is shown in Fig. 1. This casting, it will be noticed, has several deep pockets; one in the drag and two in the cope. It is necessary to strip the pattern at all difficult points, and

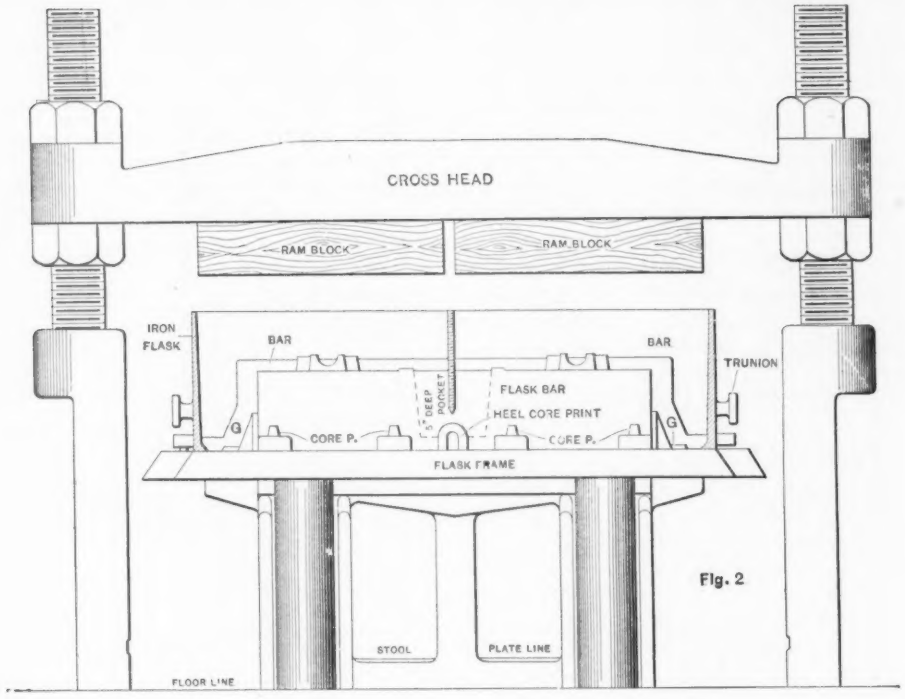
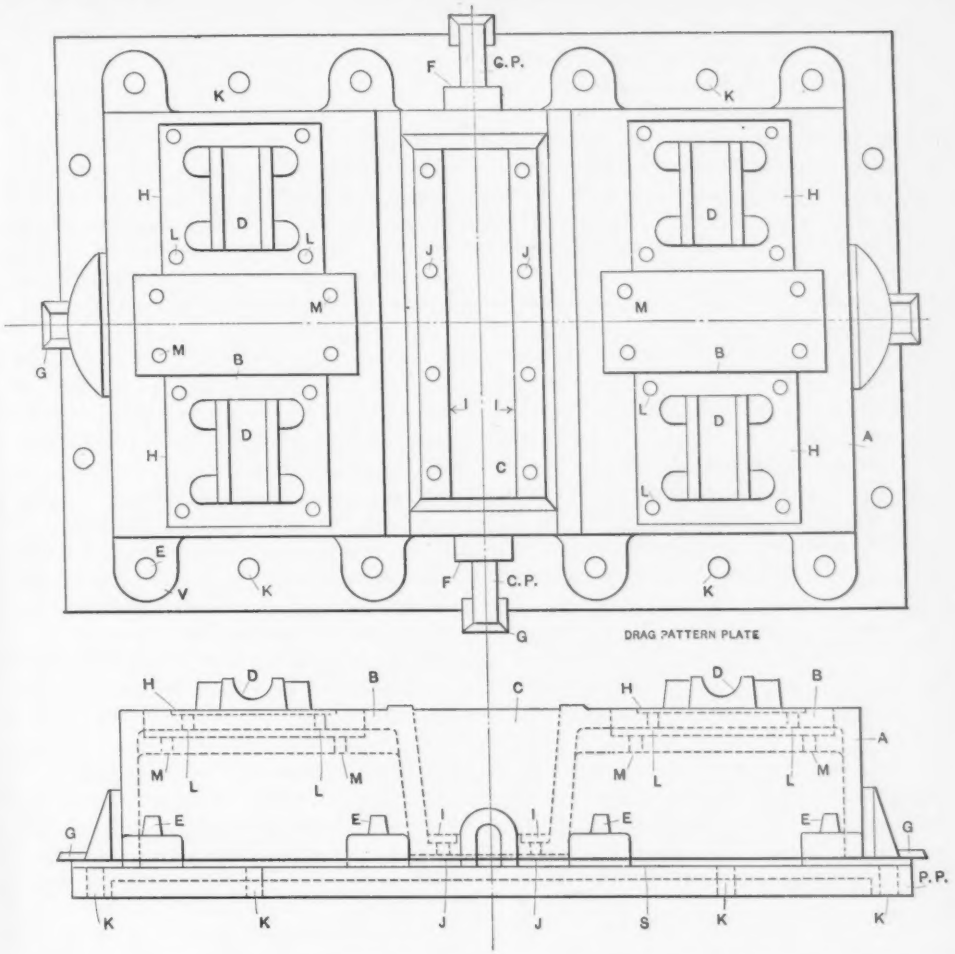


Fig. 2

there are nine dry-sand cores to be set in each mold. I will describe the mounting of the pattern first upon a power ramming machine. A machine of this type is shown in Fig. 2. This is built especially for large work and is intended to be placed in a pit in the floor. In the illustration only the portion of the machine projecting above the floor is shown. The space over the pit about the machine is covered with planks which should be so fitted that they can be removed for a periodical cleaning of the pit or attention to the running parts of the machine. The object in seting the machine in the pit is to bring the flasks as low as possible so as to reduce the work of shoveling sand into it, and of handling the finished molds. The machine is operated by three levers (not shown in the illustration), one of which brings the cross-head into position directly over the mold, the second operates the ramming device, while the third operates the stripping mechanism. The machine is so designed that there is practically no danger of its being injured by its own action, on account of any untimely throwing of the levers.

It is first necessary to decide upon the parting line, and then to split the pattern at this point. The parting line is indicated in Fig. 1. It will be noticed that the whole outside, as well as the deep pocket in the center, is made in the drag, while the remaining surface of the casting is formed in the cope.

The old wooden pattern can be altered and made to serve very well. The principal changes necessary are due to the location of the stripping plates. The pattern mounted upon the plate for the drag machine is shown in Fig. 3. At the point B there is an opening extending through the pattern, the thickness of the casting at this point being ¾ inch. It is necessary to strip the sand from this pocket and hence extra stock must be added to the back of the pattern at this point to support the stripper. The stripper being ¼ in. thick, it will be necessary to add at least ½ in. of material to the back of the pattern. It will also be necessary to cut recesses for strippers at H for stripping about the portion of the pattern D, at I for stripping the sides of the deep pockets C, and to add ¼ in. of stock to the lower face of the pattern to provide for a stripper for stripping the outside faces of the pattern.



A wooden pattern must be made for the pattern plate for the pattern A. The outside dimensions of this plate correspond with the inside dimensions of the flask frame, while the thickness of the plate must be such as to bring the top of the pattern plate to within ¼ in. of the flask frame when it is finished. The center of the plate is cut down to about ½ in. in thickness. This completes the pattern making for the drag machine.

In making the pattern for the cope machine it will be noticed that the shape is the same as the inside of the piece shown in Fig. 1. There are two pockets, each 6½ in. deep, located at the ends of the pattern, and a quarter inch recess in the center of the plate. In the bottom of each of the deep recesses, a recess one-quarter of an inch deep must be cut for the stripper O. It is also necessary to cut a recess for the strippers P. At the point Q a semi-circular pocket must be cut to correspond with the shape of the pattern at U, Fig. 1. The center of the cope plate is made a half inch thick and the outside edge increased in thickness so that this dimension is the same as the depth of the opening in the top surface of the machine in which it rests. This brings the top surface of the plate flush with the bottom surface of the flask.

It is next necessary to mount the patterns on the machine. The drag pattern plate should be planed on the top and bottom surfaces to such a thickness that when set to place on the machine the upper surface will be one-quarter inch below the flask frame on the machine. The center line should then be laid off both lengthways and across the plate. The other pattern plate is then treated in the same

manner. The drag pattern, Fig. 3, is then located on the drag pattern plate, as shown, and secured with screws. Brass strippers must be cut to fit in the bottom of the opening B. These strippers should be cut of such a thickness that when in place their surface would be three-quarters of an inch below the upper surface of the pattern. In each corner of the opening B, a hole is drilled, as shown at M. These should be five-eighths of an inch in diameter and extend clear through the wooden pattern. Eight stools are next gotten out to pass through the holes, M M, and support the strippers in the opening B. The strippers are secured to the stools with bevel head screws. These stools will be 19¾ in. long, but nevertheless should work satisfactorily. A stripper is required in the opening H to strip around the central projection of the pattern. These strippers can

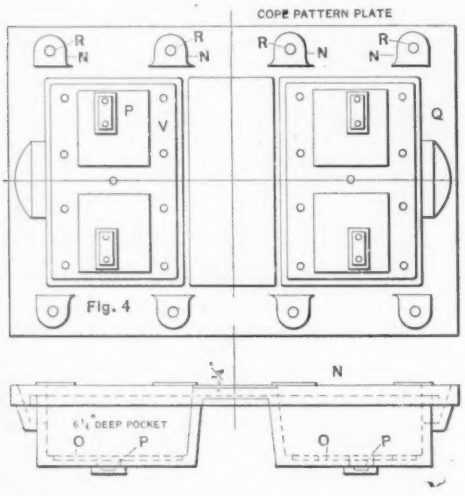


Fig. 4

be made of sheet brass one-eighth of an inch thick, and in each corner of the opening, holes, L L, can be drilled for the stools necessary to support the strippers. As there are four pockets and four stools to each stripper, it will be necessary to make 16 stools and secure them to the strippers with bevel head screws. These stools will be 20⅞ in. long. In the center of the pattern there is a recess C, with two smaller recesses I I in the bottom. It will be necessary to place a stripper in each of these. These strippers may be made of one-quarter inch brass and held in position by four stools each, as shown at J J. These stools will be five-eighths of an inch in diameter, the same as the others. It is necessary to cut out a brass stripper S to extend entirely around the pattern A and strip the outside of it. This stripper can be made of one-quarter inch brass and owing to its size it will be found best to make it in four sections. The stools for these strippers extend through the holes K K, the stools being made from three-quarter inch cold rolled steel. All the strippers should have a slight draft filed on them tending away from the upper or stripper surface, so that they will not strike or rub any part of the pattern when they are returning to place. In the center of each side of the pattern the brass stops G should be placed. These are fitted on to the strippers S.

The portion of the pattern at P, Fig. 3, cannot be finished until the pocket Q, Fig. 4, is finished, as they must correspond. The print P, Fig. 3, is first fitted to the pocket Q, Fig. 4, after the latter has been finished and is then secured to the pattern plate shown in Fig. 3. At F, Fig. 3, there is a boss that has a hole cored through it. A heel core is used for this purpose, and hence it is necessary to fasten the prints shown in Fig. 3 in place. The core is about 21 in. long and is very slender, so it is necessary to place a rod through it when ramming it up. The heel print extends down to the parting line.

Each one of the lugs V on the pattern side must have a core print attached to it, as shown at E, Fig. 3.

The pattern and pattern plate for the cope machine are shown in Fig. 4. It is first necessary to plane all parts that can be planed, the outside dimensions of plate being the same as the inside dimensions of opening in the machine. The deep pockets in the plate must be accurately finished to size, taking special care to see that they are located so that they will correspond exactly with the drag pattern. The pockets should be 6¼ in. deep, shrink rule measurement. In the bottom of each pocket two strippers are required, as indicated by the letters O and P. The strippers must be placed in the pattern so that their top surfaces are flush with the bottom surfaces of the pockets. The larger stripper is somewhat the shape of the letter "H" as shown in the plan view, Fig. 4. The inner pocket P has to be stooled.

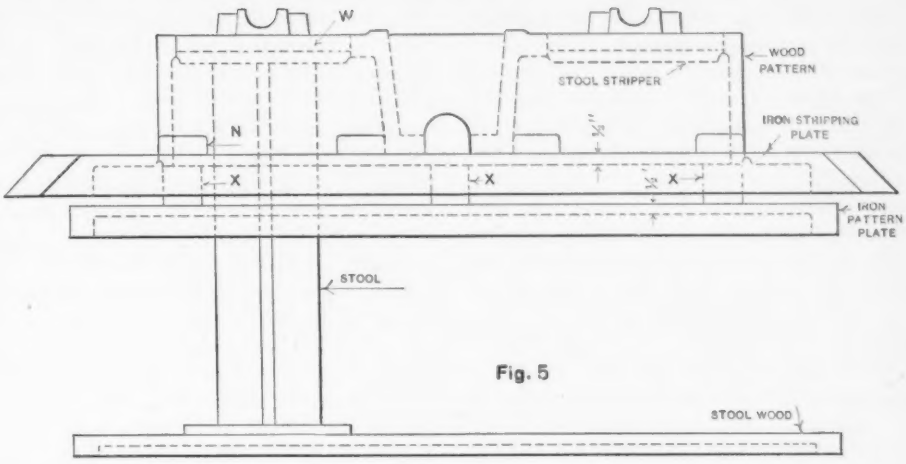


Fig. 5

There should be a clearance space between the stool and the strippers, so that when the cope is being lifted from the machine the sand core on top of the small stool will not shift and hit the large strippers. The stripper O is supported by nine stools, which are five-eighths of an inch in diameter and secured to the strippers with bevel head screws. Each one of the strippers for the pockets P, of which there are four, is supported upon two stools. There are eight lugs N, which are necessary to furnish material for finishing pads required on the casting. These can be cut out of sheet brass given a slight draft around the edge and secured on to the pattern. It is also necessary to provide a hole for a core print in the center of each one, as indicated at R. These core prints can also be turned up from brass. These finishing pads must be so located that they will come exactly opposite the lugs V. Fig. 3, and core prints opposite the prints E, Fig. 3.

It is next necessary to make a suitable iron flask. The flask is 10½ in. deep and the thickness of the walls three-eighths of an inch. A flange is provided along the lower inner edge to prevent the sand from dropping out while the mold is being lifted from the machine. The interior of the flask is divided into four parts by two bars crossing each other at right angles, as shown in Fig. 2. These bars must be made to conform to the shape of the pattern, entering down into the center of the deep pocket in the drag, while in the cope it is necessary to provide two bars, one for each deep pocket. Lugs are cast on the ends of the flask to be drilled for the flask pins. The holes for the flask pins should be drilled with a jig, so as to insure interchangeability. Owing to the fact that these flasks when fitted are heavy, trunnions are cast on the ends, as shown in Fig. 2. It will first be necessary to make a wooden pattern for the flask and to make an iron pattern from it. A follow board should be made for the iron pattern. The edges of the pattern should be planed, so that they will set level on the machines. In Fig. 2 the flask is shown in place upon the machine with the ramming blocks supported above it. These ramming blocks are attached to the cross head and so located that they will miss the cross bars in the flask.

In making this job on a drop pattern hand machine, the pattern drops down and the flask remains stationary, while in the power machine the pattern remains stationary and the flask lifts up off from the pattern. Fig. 5 shows the pattern as it would be fitted up for a hand rammed machine. In this case, of course, it would be necessary to place extra stock on the bottom of the pattern so as to bring the parting line of the pattern level with the parting line of the machine. When using the hand rammed drop pattern machine five lugs, X X, are placed under the corner lugs N and in the center of the machine, the height of these depending upon the style of the molding machine being used. They should be so arranged as to bring the parting line of the pattern even with the parting line of the machine.

The pocket W, Fig. 5, is generally

stripped out with the aid of a stripping plate and stools, as shown. The other portions of the pattern are fitted up as for the power rammed machine. In the hand rammed machine the pattern is dropped by using a lever at the side of the machine.

The mold is made in the usual way and in the case of the power rammed machine it will be necessary to strike several blows to thoroughly ram the sand. On either style of machine it will be necessary to look after the venting. The flask is lifted off by means of a bail or hooks passing under the trunnions and connected with a pneumatic hoist.—[The Patternmaker.

OIL CORES.

BY CHAS. A. SMITH.

In the writer's opinion those who make cores with resin or flour are far behind the times, and are also sure to have more or less trouble that could be easily avoided by using a different binder. Oil and nothing but oil in the writer's opinion should be used as a binder in core making. Many foundrymen think oil too expensive, but if they will stop and figure in their loss on top of the cost of the cheaper core binder, they will find that in reality they are using the dearest possible binder. In the first place it was difficult to convinced the firm for which I am now working that oil was cheaper than flour or resin. One great advantage of oil cores is that in many castings no wires or rods are required in them on account of their greater strength. This is a saving not only in the time necessary to put the wires and rods in place, but in the cleaning of the castings, straightening rods, purchase of new rods, etc. We are making a burner core 16 in. long and 1⅛ in. thick without a rod in it. We are also making some very complicated burner cores without wires, which formerly contained many of them. Cores can be rammed up and completed much quicker and, hence, cheaper when they contain no wires. One of our burner cores formerly had seven wires in it, four of which could never be removed from the casting. At present it is made with only two wires, a saving of five wires.

Very frequently the foundry superintendent will not allow his foundry foreman to experiment and, hence, he cannot determine the best mixture for any given casting. In my own case the superintendent has frequently said that we had better not change this or that mixture, as we may not be able to do as well, but in most cases a little study has enabled me to improve the results, especially in the case of many difficult jobs. The reason core rooms do not advance in their practice as they should is that many of the foundry foremen will not try new methods or permit them to be tried. Of course, many foundrymen have not had experience in core making, and for that reason do not know what can be done in the way of saving in the making of cores. If the foreman core maker has brains and is willing to use them and the foundry foreman will encourage him, both will usually reap a good reward for their trouble and planning.

One reason why there are so few good foremen core makers is that most foundrymen are not willing to pay for brains in this position, and so a bright man gets out as soon as possible. There are many ways in which a core room should improve, and in the writer's opinion the use of oil is one of the first steps. It makes smoother cores which will stand rougher handling, resist moisture, stand more heat and meet all the requirements of the foundry better than any other cores so far introduced. One good test is to make a few flour cores, a few resin cores and a few oil cores, put them away for a few weeks, and then see which cores are the best. I use the old sand over and over again which otherwise would be hauled to the dump, and this little point is certainly a great saving to the company.

THE EFFECT OF MANGANESE IN LOW SILICON CAST IRON.*

BY H. C. LOUDENBECK, WILMERDING, PA.

The following tests were made to show the effect of manganese on the chill and fracture of cast iron having a low percentage of silicon.

CONDITIONS OF TESTS.

Mixture was melted in a small test cupola having a diameter of 16 in. inside the lining. Blast pressure 6 oz. Size of chilled test pieces 3 in. x 4 in. x 10 in. These were chilled on the edge, or the 3 in. x 10 in. face. Test pieces were also cast in the sand to determine fracture, and also to obtain drillings for test. These were the same size as the chilled test pieces.

*Paper read at A. F. A. Convention, New York city, June, 1905.

TEST NO. 1.

Mixture { No. 1. Charcoal Pig Iron....40 lb.
No. 6. Charcoal Pig Iron....60 lb.
80% Ferro Manganese..... 2 lb.

	Estimated Analysis	Actual Analysis
Silicon	.63%	.55%
Manganese	2.01%	1.38%
Total Carbon	3.77%	3.67%
Combined Carbon		.62%
Phosphorus	.24%	.22%
Sulphur	.02%	.048%

Depth of chill, 2 in.; grain of chill, coarse and fibrous; fracture of sand piece, open, graphitic and very black.

One inch test bar broke at 2,600 lb. per sq. in., twelve inches between supports.

TEST NO. 2.

Mixture { No. 1. Charcoal Pig Iron..40 lb.
No. 6. Charcoal Pig Iron..60 lb.
80% Ferro Manganese..... 3 lb.

	Estimated Analysis	Actual Analysis
Silicon	.63%	.49%
Manganese	2.81%	2.00%
Total Carbon	3.77%	3.72%
Combined Carbon		.74%
Phosphorus	.24%	.25%
Sulphur	.02%	.03%

Depth of chill, 2¼ in.; grain of chill, very coarse and fibrous.

Fracture of sand test piece, mottled on the outside, black in the center.

One inch test bar broke at 2,600 lb. per sq. in., twelve inches between supports.

TEST NO. 3.

Mixture { No. 1. Charcoal Pig Iron..40 lb.
No. 6. Charcoal Pig Iron..60 lb.
80% Ferro Manganese..... 3¾ lb.

	Estimated Analysis	Actual Analysis
Silicon	.63%	.49%
Manganese	3.63%	2.25%
Total Carbon	3.81%	3.70%
Combined Carbon	1.17%	1.03%
Phosphorus	.26%	.24%
Sulphur	.02%	.025%

Depth of chill, 2.30 in.; grain of chill, very coarse, back of chill mottled.

Fracture of sand test piece, chilled on corners and sides but gray in center.

One inch test bar broke at 1,755 lb. per sq. in., twelve inches between supports.

TEST NO. 4.

Mixture { No. 1. Charcoal Pig Iron..40 lb.
No. 6. Charcoal Pig Iron..60 lb.
80% Ferro Manganese ..... 5¼ lb.

	Estimated Analysis	Actual Analysis
Silicon	.60%	.74%
Manganese	4.51%	3.80%
Total Carbon	3.87%	
Combined Carbon	1.00%	2.52%
Phosphorus	.27%	.27%
Sulphur	.02%	.02%

Chilled test piece, white throughout.

Fracture of sand test piece, white with a few graphitic spots in center.

One inch test bar broke at 1,465 lb. per sq. in., twelve inches between supports.

The above tests indicate: First—In cast iron having from .50 to .70 percent silicon, the addition of manganese above 1.38 percent, gradually hardens the metal, the combined carbon and the chill increasing with the addition of manganese.

NOTE.—The above statement should be modified for when smaller or larger castings are made the size of the casting has a marked effect on the cooling of the metal and in that way affects the carbon.

Second.—When the manganese is high and the casting large enough to be gray, the fracture is open and coarse, and the graphite scales very large and crystalline.

Third.—High manganese to a certain extent prevents absorption of sulphur from coke.

When the manganese is below 1.38 percent (this percentage is only approximate and depends largely upon the percentage of silicon present; the lower the silicon the sooner the manganese will commence hardening iron), its action is different; it softens iron, lowers the combined carbon and decreases the chill; this effect is more marked where the sulphur is high, which the following examples will illustrate:

TEST NO. 5.

Analysis of metal direct from cupola:

Sulphur	.12 per cent.
Silicon	.71 per cent.
Manganese	.27 per cent.
Combined Carbon	1.60 per cent.
Depth of chill	1.75 inches

Analysis after adding one-half pound of 80 percent ferro manganese to about 200 lb. of metal.

Silicon	.71 per cent.
Manganese	.34 per cent.
Combined Carbon	1.35 per cent.
Depth of chill	1.50 inches.

TEST NO. 6.

Analysis of metal direct from cupola:

Sulphur	1.25 per cent.
Silicon	.87 per cent.
Manganese	.27 per cent.
Combined Carbon	1.35 per cent.
Depth of chill	.70 inches.

Analysis after adding one pound of 80 percent ferro manganese to a ladle of about 200 pounds of metal:

Silicon	.83 per cent.
Manganese	.63 per cent.
Combined Carbon	.50 per cent.
Depth of chill	.30 inches.

TEST NO. 7.

Anaylsis of metal direct from cupola:

Silicon	.57 per cent.
Manganese	.35 per cent.
Sulphur	0.123 per cent.
Phosphorus	.39 per cent.
Combined Carbon	1.20 per cent.
Depth of chill	1.40 inches.

Analysis of the metal after adding 3½ pounds of 80 percent ferro manganese to about 200 pounds of iron:

Silicon	.59 per cent.
Manganese	1.70 per cent.
Sulphur	0.023 per cent.
Phosphorus	.39 per cent.
Depth of chill	2½ inches.

Combined carbon, vey high.

From the above it may be seen that manganese can be used for not only decreasing but increasing the chill, depending upon the amount of manganese used and the nature of the mixture. It will also be noticed the marked decrease in sulphur where considerable manganese is added. Such a difference is not always attainable, but the conditions in the case were favorable for such a reduction. The metal was very hot and after adding the ferro manganese the mixture was thoroughly stirred and skimmed.

CONCLUSIONS.

Manganese can be used to an advantage in low silicon and chilling iron in the following cases:

In mixtures where the percentage of scrap is large and the sulphur necessarily high (this will occur in a car wheel mixture where usually a large portion of old metal is used), the result of this increase in manganese would be lower sulphur, lower combined carbon, less chill and greater strength.

Very often chilled plates are required, having hard chilled faces and soft backs suitable for planing. Manganese added in the right proportion will reduce the tendency to mottle, and make a comparatively soft graphitic back.

In all cases where chilling irons are melted in a cupola and the sulphur is over .07 percent, the iron can be strengthened by the use of ferro manganese or pig iron having a high percentage of manganese.

There are some cases where the manganese should be kept low. In the manufacture of large hydraulic cylinders it is necessary to have a close mottled iron to withstand the pressure and prevent leakage. If the manganese is too high this mottled structure is replaced by a coarse graphitic structure, which is not satisfactory for this class of work. This is illustrated by the two following examples:

Analysis of hydraulic cylinder having 6-in. wall, fracture having a close mottled structure; cylinder very satisfactory.

Silicon	.90 per cent.
Manganese	.25 per cent.
Total Carbon	3.34 per cent.
Combined Carbon	1.44 per cent.
Sulphur	0.136 per cent.
Phosphorus	.39 per cent.

Analysis of a hydraulic cylinder having 6-in. wall, fracture open and not mottled; cylinder not satisfactory.

Silicon	.71 per cent.
Manganese	.49 per cent.
Total Carbon	2.98 per cent.
Combined Carbon	.65 per cent.
Sulphur	.12 per cent.
Phosphorus	.31 per cent.

A study of the above analysis will bring out the following facts:

Manganese was too high in the defective cylinder, which accounts for the low combined carbon and soft character of the mixture. Without doubt this cylinder would have been satisfactory if the manganese had been lower. This was true of subsequent tests. Twenty cylinders were afterwards cast which were satisfactory, having low manganese, high combined carbon, and a fracture having a mottled structure.

ASSOCIATIONS AND SOCIETIES.

Cleveland Foundry Foremen.

W. H. Nicholls, 608 Gordon Avenue, Secretary and Treasurer.

The Cleveland Club of Associated Foundry Foremen, together with the Cleveland Club of Associated Patternmaker Foremen, have planned an outing at Put-in-Bay for August 26, which is too late for it to be reported in this issue, but a full report of the affair will be published next month.

PHILADELPHIA FOUNDRY FOREMEN.

W. P. Cunningham, Secretary, Pencoyd, Pa.

NEW ENGLAND FOUNDRYMEN'S ASSOCIATION.

Fred F. Stockwell, Secretary, care of the Barbour-Stockwell Co., Cambridgeport, Mass.

PITTSBURG FOUNDRYMEN'S ASSOCIATION.

F. H. Zimmers, Secretary, care Union Foundry and Machine Co.

PHILADELPHIA FOUNDRYMEN'S ASSOCIATION

Howard Evans, Secretary, care J. W. Paxson Co.

THE ASSOCIATED FOUNDRY FOREMEN.

Frank C. Everitt, Secretary, 2413 Third Avenue, New York, N. Y., care the J. L. Mott Iron Works.

Note: All communications for the society should be addressed to the secretary.

President, David Reid, Canadian Westinghouse Co., Hamilton, Canada; first vice president, W. H. Nicholls, Berkshire Mfg. Co., Cleveland, O.; second vice president, Hugh McPhee, Eaton, Cole & Burnham Co., Bridgeport, Conn.

Vice Presidents are as follows: For Erie Association, W. F. Grunau, Erie City Iron Works, Erie, Pa.; for Milwaukee Association, William Beck, of the Brand Stove Co., Milwaukee, Wis.; for Chicago Association, Mr. Thomson, Link Belt Co., Chicago, Ill.; for Indianapolis Association, W. S. Keller, of Hetherington & Berner Co., Indianapolis, Ind.; for New York Association, C. H. Thomas, So. Norwalk, Conn.; for Cleveland Association, A. L. Hott, Interstate Foundry Co., Cleveland, O.; for Philadelphia Association, A. T. William, Enterprise Mfg. Co., Philadelphia, Pa.; for Hamilton, Canada, Association, Frank Reid, D. Moore & Co., Hamilton, Canada.

NEW YORK FOUNDRY FOREMEN'S ASSOCIATION.
C. H. Thomas, 14 Elizabeth St., So. Norwalk, Conn, District Vice President.

ERIE FOUNDRY FOREMEN.
W F. Grunau, Dist. Vice Pres., care Erie City Iron Works.

HAMILTON, ONT., FOUNDRY FOREMEN'S ASSOCIATION.
A. Chase, care Sawyer & Massey Co, Secretary and Treasurer.

INDIANAPOLIS FOUNDRY FOREMEN.
W. S. Keller, of Hetherington & Berner Co., District. Vice President.

CINCINNATI FOUNDRY FOREMEN.
E. W. Cadwell, Secretary.

MILWAUKEE FOUNDRY FOREMEN
Sol. Shaw, care Clinton Street Foundry of Allis-Chalmers Co., Secretary.

CHICAGO FOUNDRY FOREMEN.
Mr. Thompson, Link Belt Co., District Vice President.

TRADE PUBLICATIONS.

The Orford Copper Co., of 42 Exchange place, New York city, has brought out a publication entitled "Nickel Steel: Its Properties and Application." This is an authorized reprint of the paper by Albert L. Colby, which was read before the American Society for Testing Materials. In addition to the paper the discussion which took place in connection with the meeting has been printed. All who are interested in nickel steel or its applications will find this publication exceedingly interesting reading.

The C. W. Hunt Co., of West New Brighton, N. Y., has issued a new edition of its book entitled "Manila Rope," in which is described this class of rope, the method of splicing, the transmission of power by Manila rope, etc. The catalogue contains a very large amount of exceedingly valuable information.

The Quaker Mfg. Co., of Chicago Heights, Ill., has issued a new catalogue of its furnaces and heaters, which shows exterior and sectional views of all the different classes made by this company; also diagrams for the arrangement of piping, etc., for heating houses. This catalogue is 10¼ x 6½ in., and we cannot help but wonder why standard size would not have been better for all purposes, as it would probably have saved many copies of the catalogue from going into the waste basket.

The J. D. Smith Foundry Supply Co., of Cleveland, O., are sending out a neat little book calendar and diary book, which contains tables of useful information and places for cash accounts and diary, and maps of the United States and Cuba, also a place for memoranda and another for addresses. It contains calendars for both 1905 and 1906.

PERSONALS.

L. E. Thomas, formerly with the United Engineering & Foundry Co., Pittsburg, has accepted the general management of the Birdsboro Steel & Machine Co., Birdsboro, Pa. Mr. Thomas assumed his new duties Aug. 1. The engineering work on the new rail mill of the Republic Iron & Steel Co., Youngstown, was in his charge. Another piece of engineering work conducted by him was the construction of the Ohio plant of the Carnegie Steel Co.

E. J. Caughey has been appointed works manager of the American Car & Foundry Co.'s plant at Huntington, W. Va. He was formerly manager of the Standard Steel Car Co.'s works at Butler, Pa.

Geo. C. Forgeot has been appointed works superintendent for the Allis-Chalmers Co. Mr. Forgeot was for some years in the employ of the Edward P. Allis Co., and will now have general supervision over the plants of the Allis-Chalmers Co. His headquarters will be in Milwaukee.

Mr. Charles Parsons, of Chicago, well

known in the pneumatic tool business, is now associated with the Independent Pneumatic Tool Co., of that city, and will travel in the Chicago territory.

George Pickup, who has been with the Adams Co., of Dubuque, Ia., has resigned his position and gone to Newark, O., to assume the management of the Wehrle Stove Works of that place.

John H. Harding, who goes to Dunkirk, N. Y., as assistant foreman of the Brooks Works foundry of the American Locomotive Co., will be succeeded in Schenectady by Thos. J. Foley.

A. E. Croft has been made vice president and general manager of the Featherstone Foundry & Machine Co., Chicago, to succeed H. H. Wright, who was killed last month in the Lake Shore train wreck at Mentor, O.

DEATHS.

Robert J. Kohler, president of the Kohler Foundry Co., at Sheboygan, Wis., was found dead in bed on Friday morning, Aug. 4. His physicians attribute his death to heart disease.

Mr. Rockwell King, president of the King & Andrews Co., of Chicago, Ill., died at Chicago, Thursday, July 27.

William Mellen, senior member of the brass foundry firm of William Mellen & Sons, died on Wednesday, July 26, at his home in Milwaukee, Wis.

Robert Winslow, who was the first foreman of the foundries at the University of Michigan, at Ann Arbor, Mich., died at Ann Arbor on July 22. Mr. Winslow was 73 years of age and had charge of the shops for twenty years. His death resulted from a fall sustained a few days before.

Theodore Townsend, of Albany, N. Y., died Aug. 3, at Westport, where he had been enjoying a vacation. Mr. Townsend's illness was of but one week's duration and his death comes very suddenly. Educated at Albany and Poughkeepsie preparatory schools, he entered Union College, and after being graduated, engaged in the iron and foundry business with Franklin and Frederick Townsend in 1846. Mr. Townsend had always been a prominent business man and leaves two daughters and a son besides his widow.

FIRES.

One of the buildings belonging to the Fagan Iron Works Co., Jersey City, N. J., was destroyed by fire on Aug. 1. On May 2 last two of the three buildings comprising the plant were destroyed by fire and new buildings are now under construction to replace them. The burning of the third building will necessitate the entire reconstruction of the plant, though fortunately, the fire was confined to the old building, so that the work on the new structures can go forward at once.

The plant of the Tower Grove Foundry Co., of St. Louis, Mo., was damaged by fire to the extent of $1,500 on Aug. 2.

A frame building occupied by the Davidson Foundry Co., at Maywood, Ill., was destroyed by fire on Aug. 3. The loss was $3,000.

Fire destroyed the Union Iron Foundry at Georgetown, near Seattle, Wash., on July 25. The plant was valued at $20,000. This plant was formerly owned by Goldberg & Bernard and was sold to Eastern parties recently.

The plant of the Ireland & Matthews Mfg. Co., of Detroit, Mich., was damaged by fire to the extent of $100,000, on July 10. The loss is said to be covered by insurance.

NEW CONSTRUCTION.

Hill & Bostley, foundrymen, are constructing a new foundry 48 x 120 ft., near the Boston & Maine Railroad station, Winchendon, Mass. They will vacate their present quarters in the near future.

The Davison-Namack Foundry Co., Ballston Spa, N. Y., contemplates erecting an addition to its molding room and will probably be in the market for a blower and tumbling barrel.

Work has been started upon the construction of a new foundry and machine shop at Lewistown, Pa. Mr. Dan W. Ford is at the head of the new company.

The Scranton Steam Pump Co., Scranton, Pa., is building a new foundry 280 ft. long by 60 ft. wide with a wing 120 x 60 ft. The building will be of steel construction and be equipped with electric cranes, air molding machines and all modern foundry equipments.

Ballinger & Perrot, architects, have completed plans for a one-story foundry building, together with offices and storage buildings, 50 x 201 ft., with a wing 40 x 92 ft., for the Bernstein Mfg. Co., Philadelphia, Pa.

The Western Steel Foundry Co., with a capital of $3,000,000, promoted by W. F. Watson, of Pittsburg, will build a plant at Alliance, O., to manufacture all kinds of open hearth steel. The plant will cost $150,000.

E. A. Walshe & Sons have prepared plans for a new plant for the Thos. H. Conway Stove Co., to be built at Fremont, O. The estimated cost is $110,000. The dimensions of some of the buildings are as follows: Offices and show rooms, 48 x 135 ft. and two stories high; steel room building, 70 x 75 ft. and one story high; shipping room, 45 x 200 ft. and one story high; boiler and engine room, 35 x 77 ft. and one story high; a foundry 82 x 500 ft. and one story in height; a stamping room, 86 x 313 ft. All of the buildings are to be fireproof, with metal window sashes and frames.

The Columbiana Foundry Co., Columbiana, O., will erect a foundry building in the near future. The plans are being prepared by Architects Searles, Hirsh & Gavin, 308 Electric building, Cleveland. The building will be 100 x 100 ft., of brick construction with steel trusses, and will cost $2,500.

The O. S. Kelly Western Mfg. Co., Springfield, O., has decided to erect a foundry of its own and will begin work on it at once, so that in the future it will not have to purchase castings from outside parties.

Mr. C. W. Bellows has had plans and specifications prepared for a large addition to be made to the plant of the E. N. Hulse Iron Foundry, of Columbus, O.

The William Bailey Co., of Springfield, O., will build an addition to its plant for foundry purposes. which will double the present capacity of the plant.

The Buckeye Steel Castings Co., Columbus, O., has found it necessary to make preparations for a large number of additions and improvements in its plant owing to the heavy rush of business.

Architect L. G. Welker has awarded the contract for the additions to the plant of the Ensign Foundry Co., of Auburndale, Toledo, O., to J. Compte. The improvements will cost about $15,000, and are to be completed by Sept. 1.

Jas. Digan, who has conducted a foundry business at Logansport, Ind., has recently erected a new foundry at Dennison, O. His brother, John Digan, of Lagonda, will be placed in charge of the new plant.

The recently reorganized Evansville Foundry Association, Evansville, Ind., has purchased the site and buildings of the former Evansville Cabinet Mfg. Co., and will remodel the buildings to suit its needs.

The Holland Radiator Works at Bremen, Ind., will build a new foundry addition 90 x 150 ft. in dimensions.

The Indiana Foundry & Machine Co., South Bend, Ind., contemplates erecting an addition to its main foundry. Several smaller buildings will also be erected for general all round enlargement of the plant.

The new foundry plant of Deere & Co., Moline, Ill., is practically completed.

The new buildings of the Chicago Hardware Foundry Co., North Chicago, are nearly completed. They include one building 100 x 80 ft., two stories high, to be used as stock and shipping room, another building 100 x 40, one story high with a loft to be used half for a carpenter shop and half for a store room, and a flask shed 16 x 300 ft., one story high. The first mentioned buildings are of brick and iron construction and the other of wood. Its machinery and construction material has already been purchased.

The Illinois Machine & Foundry Co., of Chicago, Ill., is to erect a new plant at Decatur, Ill., the Chamber of Commerce of Decatur having given them a free site and a bonus of $14,000.

At a meeting of the directors of the West-Allis Malleable Iron & Chain Belt Co., Milwaukee, the old officers were re-elected, and it was definitely decided to proceed with the new construction contemplated. The addition to the foundry will be 70 x 220 ft. and the addition to the machine shop 70 x 64, two stories in height. The new machinery will cost $3,000 and has been purchased. The enlarged plant will employ in the neighborhood of 400 men.

Mr. Paul Marshall, of Three Rivers, Mich., has secured a lease upon a piece of ground at Constantine, Mich., and will erect a foundry at once.

The Grand Rapids Foundry Co. will build a one-story brick foundry building, 100 x 100 ft. to cost $6,600, in Grand Rapids.

The Veitch Foundry & Machine Works at Bessemer, Ala., will erect buildings, the first one of which for immediate use will be 30 x 75 ft.

The contract for the erection of the main

building of the Sheffield Cast Iron Pipe & Foundry Co.'s plant, at Sheffield, Ala., has been awarded to the American Bridge Co., of Pittsburg, Pa. The main building is to be 600 ft. long. There will also be a number of other buildings.

The Lombard Iron Works & Supply Co., of Augusta, Ga., has awarded a contract for an extensive addition to its foundry and boiler shop.

The Central Foundry Co., of Bessemer, Ala., has decided to make extensive improvements to its plant and install considerable new machinery, including pneumatic appliances.

The American Car & Foundry Co. will greatly increase the capacity of its plant located at Jeffersonville, Ky.

The Bessemer Machine & Foundry Co., Birmingham Ala., is enlarging its plant at Eighth avenue and Twenty-fourth street by 100 ft.

The Dominion Coal Co. Ltd., Glace Bay, C. B., is planning to build a new foundry, 60 x 120 ft. The work of the company consists largely in general mining, railroad and steamship repairs.

GENERAL INDUSTRIAL NOTES.

The first run in the Coosa Pipe & Foundry Co.'s plant at Gadsden, Ala., was made on August 6, when a quantity of soil pipe was turned out.

The Lansing Foundry Co., Lansing, Mich., has increased its capital from $20,000 to $30,000.

The Hay Foundry & Iron Co., Newark, N. J., recently moved part of its plant bodily to a new location.

The Page Washing Machine Co., of Des Moines, Ia., announces that it intends to build a foundry plant for the production of its own castings.

The United Iron Works Co., of Aurora, Mo., is planning to erect a new foundry building.

Mr. O. H. Cunningham has ordered equipment for a new foundry in Sheridan, Wyo. This is the first foundry in northern Wyoming.

The two foundries of the Great Western Foundry Co., of Leavenworth, Kan., which have been closed down for repairs, are running full blast once more, and hope to continue all winter.

The Fort Payne Stove & Foundry Co., of Fort Payne, Ala., is now composed of J. B. Haralson, W. C. D. Cook, J. G. Mickler, S. B. Slone and T. J. Cook. The capital stock is $9,000. The first run since the rebuilding of the plant was made in July and was very successful.

D. N. Clark, manufacturer of Clark's metallic filler, is changing the name of his company to the Shelton Metallic Filler Co., of Shelton, Conn. The object in changing the name is to avoid confusion which now arises from another company having a similar name.

The Colonial Foundry & Machinery Co., South Norwalk, Conn., as a result of their recent increase in the size of their plant are able to turn out 25 to 30 tons a day consisting of castings, none of which run over a ton in weight. The demand for the Argand steam hot water boilers, the making of which constitutes a large part of their business has increased very rapidly, necessitating the enlargement of their plant.

The North & Judd Mfg. Co., of New Britain, Conn., has been improving its plant by increasing the area of the windows and making other improvements which will render the work easier

Mr. L. H. Miller, who recently assumed the management of the Providence Steel Castings Co., Providence, R. I., announces that the output of the plant has about doubled in the past three months, and that they are running a night force.

The Mill Machinery Manufacturers of Sandy Hill, Troy, N. Y., has been incorporated to make and sell foundry supplies. The capital stock is $10,000 and the directors are William J. Gallagher, B. G. Higsbey, Sandy Hill, and Frank M. Chapman.

The Bain, Law & Ball Foundry Co., of New York, has been incorporated to manufacture brass, iron and steel products. Capital stock, $15,000. The incorporators are Duncan Bain, 3278 Hull avenue, The Bronx; Albert Law, 282 Tompkins avenue, Brooklyn; Wm. H. Ball, Spuyten Duyvil, N. Y.; Anna A. Byrne and John C. Giesler, both of 55 Liberty street, New York.

Harry Haner, of Owego, N. Y., has added a brass department to his foundry.

The Ingersoll-Rand Co., has taken possession of its new offices on the fourteenth floor of the Bowling Green Building, No. 11 Broadway, New York city. The offices of the Ingersoll-Sergeant Drill Co., 26 Cortlandt street, and of the Rand Drill Co., 128 Broadway, have been given up and all of the

office force combined at the new quarters.

Esenwein & Johnson, architects, have completed plans for an extension to the plant of the American Brake Shoe & Foundry Co., at Buffalo, N. Y., to cost between $15,000 and $16,000.

The Lancaster, (N. Y.) Malleable Iron Works is to be remodeled and equipped as a first class malleable casting plant by the American Brake Shoe & Foundry Co. It will be operated as a separate corporation, subsidiary to the Brake Shoe & Foundry Co., and will be known as the American Malleable Iron Co.

The directors of the National Cast Iron Co., of Avonmore, Pa., at a meeting held recently elected the following officers for the coming year: President, Homer W. Chase, president of the Truss Steel Tie Co., of Pittsburg; Vice president, Ira C. Ewing, superintendent of the Avonmore Land & Improvement Co., of Philadelphia; Secretary, Lyman S. Ailes, secretary of the Truss Steel Tie Co., of Pittsburg; Treasurer, G. M. Hine, president of the First National Bank of Avonmore. The other directors of the company are the following well known business men: R. W. Davies, president and manager of the West Penn Foundry & Machine Co., Avonmore; Thomas H. Gough, secretary and treasurer of the Hill Lumber Co., of Avonmore, and M. V. Patterson, proprietor of the Patterson Milling Co., of Saltsburg, Pa. Details of their organization and condition are given in a little booklet issued under their direction, entitled "The Science of Investment."

The Brighton Brass & Bronze Co., of New Brighton, Pa., has been incorporated under the laws of the state of Pennsylvania, with $50,000 capital. The new company will take over the business of the old company of the same name. Some of the stockholders of the company are as follows: W. H. Schoen, L. G. Woods, A. R. Bassett, and George T. Hildebrand, all of Pittsburg. Mr. W. H. Berry is also interested and will be vice president and general manager. The foundry has a capacity of ten tons of brass and bronze castings per day. The new company intends to enter largely into the manufacture of railroad car brasses, rolling mill bearings and blast furnace castings.

The Baldwin & Graham Stove Foundry, of Newcastle, Pa., which was closed down recently for three weeks for extensive repairs, has everything going once more for a long campaign.

The United States Furnace & Foundry Co., manufacturer of heating furnaces and sanitary appliances, whose principal office is in Pittsburg, has just completed arrangements for the erection of a new plant at Darlington, Beaver county, Pa. The plant is to be completed by October 1, and will be strictly up-to-date in arrangement and equipment. Electric transmission of power, compressed air, molding machines and pneumatic tools will be used.

A $56,000,000 company has been formed to carry on the manufacture of cars. The following concerns have entered into the merger: The J. G. Brill Co., Philadelphia, Pa; The John Stephenson Co., Elizabeth, N. J.; The American Car Co., St. Louis, Mo.; The G. C. Kuhlman Car Co., Cleveland, O.; The St. Louis Car Co., St. Louis, Mo.; The Laclede Car Co., St. Louis, Mo.; The Malleable Casting Co., St. Louis, Mo.; The Cincinnati Car Co., Cincinnati O.; The Wason Mfg. Co., Springfield, Mass.; Osgood, Bradley & Sons, Worcester, Mass.; The John J. Cummings Car Co., Paris, Ill.; The Jewett Car Co., Newark, O.; J. M. Jones Sons, Agents, Troy, N. Y.; The Laconia Car Co., Laconia, N. H.; The McGuire-Cummings Mfg. Co., Kingston, N. Y.; The Niles Car Co., Niles, O.; The Spiral Bearing & Supply Co., St. Louis, Mo.; The Easy Access Door Co., Boston, Mass.

The Sharon Foundry Co., Sharon, Pa., will build a 20-ton open hearth furnace and will furnish steel castings as well as iron. Mr. Joseph Riddell has resigned as president and manager and W. W. Shilling was elected president and P. McManus has been appointed superintendent. Mr. McManus was with the American Steel Casting Co., now the American Steel Foundry, for a number of years, and for the past two years was superintendent of the Sterling Steel Foundry at Braddock, Pa.

Rogers, Brown & Co., who recently moved their Cleveland offices from the Perry-Payne building to a handsome suite, 1312-1318 Rockefeller building, the new skyscraper recently completed, announce that they will have on file periodicals devoted to the foundry and iron trade, to which all visitors will have access. Sterling W. Hubbard and Harwood Wilson are the resident managers.

The Youngstown (O.) Foundry & Machine Co., at its recent annual meeting elected the following officers and directors: President, Thomas Parrock; vice president, T. B. Van Alstine; secretary and treasurer, F. A. Wil-

liams; these together with M. J. Wallis, Geo. E. Rose, M. E. Coombs and E. B. Lawrence make up the board of directors.

The Watt Cupola Twyer Co., of Barnesville, O., announces that it has appointed the Thomas W. Pangborn Co., of New York, as its exclusive Eastern agent.

The Forsythe Pattern Co., of Youngstown, O., which was originally incorporated under the laws of the State of Delaware, has had that incorporation dissolved and reincorporated under the laws of Ohio. The capital stock of the company is $50,000. At the meeting of the directors recently the following officers were elected: Frank D. Runser, president and manager; Geo. J. Renner, vice president; E. H Arnold, secretary, and John Stambaugh, treasurer.

The Werntz & Holland Co., of Warsaw, Ind. is improving its foundry and expects soon to build an addition which will double its capacity.

Seward & Co., foundrymen of Bloomington, Ind., have purchased the machine shops of Edwin R. Fletcher and will locate their foundry on that site. Their old plant, which is in the center of the town, will be disposed of for business purposes.

At the annual meeting of the Indiana Foundry & Machine Co., South Bend, Ind., the following officers and directors were elected for the ensuing year: F. L. Dennis, Joseph Bergan, W. N. Bergan, A. A. Forsyth, and C. W. Fassett. The president is C. W. Fassett; vice president, Joseph Bergan, and secretary and treasurer, Max Konzen.

The Griffin Wheel Co., Chicago, has increased its capital stock from $4,000,000 to $5,000,000.

Sears & Roebuck, of Chicago, Ill., have purchased land near Mt. Vernon, O., and it is stated that they are planning to erect a stove foundry.

The McIntosh Foundry & Machine Co., of Monmouth, Ill., has been incorporated with a capital of $10,000. The incorporators are A. D. McIntosh, W. A. Miles and J. F. Duffin.

The Baltimore Foundry Co., of Baltimore, Md., has been incorporated by Andrew J. Dietrich, Hammond Dietrich, Jacob C. Dietrich, A. Clarence Dietrich and John W. Diven. The purpose of the new company is to take over the old Lorraine plant located in Baltimore, and to improve it and put it in shape for a general foundry and machine shop business. The foundry building proper is 104 x 300 ft. The capital stock of the company will be $30,000.

The Asbury Graphite Mills, at Asbury, Warren county, N. J., are being remodeled and enlarged. This is the fourth time it has been necessary to increase the capacity of these mills since they were founded ten years ago.

The Grand Rapids Foundry Co., of Grand Rapids, Mich., will erect a foundry building, 100 x 100 ft., to cost $6,600.

The Gale Mfg. Co. and the Albion Malleable Iron Co., both of Albion, Mich., have been shut down only long enough to make needed repairs because the press of business necessitates the immediate resumption of operations.

The Gisholt Machine Co., Madison, Wis., machine tool manufacturers, has just completed arrangements for acquiring the plant of the American Turret Lathe Co., of Warren, Pa. The company has been reorganized with an increase of capital stock from $750,000 to $1,250,000.

The Detroit Foundry Supply Co., of Detroit, Mich., has been incorporated with a capital of $25,000, to conduct a general foundry supply business. The incorporators are Edw. J. Woodison, Lorenzo A. Crandall, Wm. F. Bartlet, W. Bruce Howard and John A. Preston. The company has been doing a good business for over a year and feels that the present outlook warrants its incorporation.

In the last issue of *The Foundry* we had a notice of the new plant of the Frictionless Metal Co., Chattanooga, Tenn. Since that date we received from the company a letter stating that we had made a mistake in quoting its output. It is 24,000 pounds per day instead of 4,000 pounds.

The Means & Fulton Iron Works, Birmingham, Ala., has changed its name to the Birmingham Engineering & Casting Co., with an increase of capitalization of $75,000.

The Central Foundry Co., Bessemer, Ala., will improve its plant in the near future by the addition of new machinery for its pipe works.

The Fair Foundry Co., of Grove City, Tenn., has recently completed a new warehouse.

The Olive Hill Light & Foundry Co., of Olive Hill, Ky., has been organized and has installed a foundry and machine shop.